UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
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OFFICE OF
PREVENTION, PESTICIDES
AND TOXIC SUBSTANCES

MEMORANDUM

Date: 3/3/00

Subject: update to 12/21/99 version of **MOLINATE**: The ORE aspects of the HED Chapter of the Reregistration Eligibility Decision Document (RED)

Case: 818845 PC Code: 041402 DP Barcode: D263662

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The Occupational and Residential aspects of the Human Health Assessment for the Reregistration Eligibility Decision (RED) document for molinate is attached. Estimates of exposure are based on several exposure studies submitted to the Agency by the Registrant, Zeneca Ag Products. Toxicology endpoints used in to for risk estimates were based on the 10/30/99 HED report, *Molinate: Report of the Hazard Identification Assessment Review Committee.*

HED's Exposure Science Advisory Council (ExpoSAC) and Risk Assessment Review Committee (RARC) was briefed concerning policy issues pertaining to the development of this chapter.

This memo is an update to the previous 12/21/99 version.

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1.0 Executive Summary

This document contains the occupational exposure assessment for molinate's only registered use, rice. The document also includes potential risk mitigation measures such as personal protective equipment (PPE) and engineering controls for handlers.

Molinate is a thiocarbamate herbicide used for the control of various weed species in rice including barnyard grass, dayflower, sprangletop, and signalweed. Molinate is also used to reduce competition from red rice. The specific mechanism for the herbicidal activity of molinate is unknown. There are no residential uses registered for molinate, therefore no residential risk assessment was completed.

Molinate is formulated as either an emulsified liquid or granular product. Molinate applications intended for weed control in rice are predominantly made by aircraft (approximately 90 percent of total applied) while the remaining applications are completed by ground-based equipment designed to apply granulars or by typical groundboom spray rigs. Maximum application rates for molinate on rice range from 3 to 5 lb ai/acre. The majority of end-use products containing molinate are reportedly sold in bulk packaging to accommodate large quantity of product handled during aerial applications.

HED has determined that there is a potential for exposure from handling molinate products during the application process (i.e., mixer/loaders, applicators, flaggers, mixer/loader/applicators) and from entering agricultural areas previously treated with molinate. Occupational postapplication exposures, however, are expected to be minimal because of the nature of the activities associated with rice cultivation (e.g., scouting and water management) and the protective equipment that is commonly used during these activities (e.g., waterproof rubber boots for walking through rice paddies). This document addresses the exposure and risk for eleven handler scenarios.

Multiple **handler** exposure studies were conducted by the registrant and submitted to the Agency. The handler data collected included biological monitoring and passive dosimetry data. These data, along with surrogate data from the Pesticide Handlers Exposure Database (PHED) Version 1.1, were used to assess the potential exposures resulting from handling and applying molinate. Potential exposures and internal doses were calculated using unit exposures (i.e., normalized to amount of active ingredient handled -- mg/lb ai handled) from both passive dosimetry and biological monitoring data multiplied by the amount of molinate handled per day (i.e., lb ai/day). The amount of molinate assumed handled per day was derived from the various application rates and the number of acres (or gallons or lbs of product) that could be applied in a single day. When PHED data were used, dermal and inhalation margins of exposure (MOEs) are presented separately (8 of 11 scenarios). When PHED data were used, three exposure levels were assessed: baseline clothing, additional clothing, and engineering controls. Assessments using data from biological monitoring of workers are presented as combined total MOE (3 of 11 scenarios). Since biomonitoring data represents exposure via all routes of exposure, the effect of additional mitigation measures not included in the studies can not be determined.

In October 1998, the Hazard Identification Assessment and Review Committee (HIARC) reassessed toxicological endpoints for non-dietary exposure to molinate. The short-term (1-7 days) dermal toxicological endpoint dose was assessed at 1.8 mg/kg/day, an oral LOAEL from a developmental neurotoxicology study. The intermediate-term (8 days to several months) dermal toxicological endpoint dose was selected from an oral dose NOAEL of 0.2 mg/kg/day . A dermal absorption rate of 40 percent was assigned to both short- and intermediate-term dermal exposures. Due to the selection of a LOAEL for the short-term dermal endpoint dose, a occupational dose that results in a Margin of Exposure (MOE) $\geq$300 is below the Agency's level of concern. Intermediate-term dermal occupational dose with an MOE $\geq$100 is below the Agency's level of concern.

The HIARC also selected inhalation short- and intermediate-term endpoints for use in the occupational reregistration risk assessment. The short-term inhalation toxicological endpoint dose selected was a NOAEL of 20.9 mg/kg/day. The intermediate-term toxicological endpoint dose selected was a NOAEL of 0.078 mg/kg/day. Both short- and intermediate-term occupational inhalation doses that result in MOEs $\geq$100 are below the Agency's level of concern.

Short- and intermediate-term <u>risks were calculated from PHED exposure data</u> for dermal, inhalation and the combined exposures (dermal and inhalation). It was concluded that the dermal and inhalation exposures could be combined due to the common endpoint for short-term (neurotoxicity) and intermediate-term (reproductive effects) exposures. Since the short-term dermal endpoint was based on a LOAEL with an additional uncertainty factor of 3, the LOAEL was divided by 3 before calculating the combined short-term dermal and inhalation MOEs. The intermediate-term dermal and inhalation endpoints were both based on a NOAEL so this additional step was not necessary for the combined intermediate MOEs. A combined MOE of <u>less than 100</u> exceeds the Agency’s level of concern.

In this document <u>three assessments utilize data from biological monitoring</u> reflect exposure via all routes (i.e. dermal, inhalation, and oral). For three these assessments, the short-term and intermediate-term endpoints selected from the previously mentioned oral studies were compared to unit exposures derived from biological monitoring data to estimate a risk that relates to exposure via all routes of exposure. For the 3 biological monitoring scenarios, calculated daily absorbed doses with a short-term MOEs <u>less than 300</u> and intermediate-term MOEs <u>less than 100</u> are below the Agency's level of concern.

To estimate cancer risk for handlers, lifetime average annual doses (dermal + inhalation) were compared to the $Q^*_1 = 4.92 \times 10^{-2}$ $(mg/kg/day)^{-1}$. A cancer risk of greater than 1.0×10^{-6} exceeds HED’s level of concern for the general population. For occupational exposures, HED’s level of concern is exceeded when cancer risks greater than 1.0×10^{-4}.

Cancer risks estimated for the eleven handler scenarios in this assessment are all less than 1×10^{-4} (range: 1.1. x 10^{-5} to 6.7×10^{-7}). The application of either additional PPE or engineering controls resulted in cancer risk of less than 1.0×10^{-6} for 5 of the 11 handler scenarios. The remaining six scenarios have cancer risks in the 1.0×10^{-6} to 1.0×10^{-4}.

Short-term MOEs estimated for liquid and granular mixer/loaders using biomonitoring data are <u>less than 300</u> at the baseline level of personal protective equipment (i.e., long pants, long sleeved shirts, gloves) and for the additional personal protective equipment (PPE) of coveralls over long pants, long sleeved shirts, chemical resistant gloves, and full face respirators. Short-term total MOEs estimated for truck drivers supporting loading of granulars for aerial applications (using biomonitoring data) are greater than 300.

Short-term dermal MOEs estimated for 8 handler scenarios using PHED data are all less than 300 at the baseline clothing and additional PPE levels (MOEs ranged from 32 to 230). Engineering controls resulted in short-term dermal MOEs above 300 for only 3 of the 8 scenarios.

Short-term inhalation MOEs estimated for 8 handler scenarios using PHED data are above 100 at the baseline level of clothing/PPE.

When the short-term dermal and inhalation MOEs are combined, the MOEs were below 100 for all scenarios at the baseline level and when additional protective clothing/PPE are added. When engineering controls are added, the MOEs are still below 100 for pilots applying both granular and liquid formulations and for handlers mixing/loading liquids for ground-based application and applying liquids using ground-based equipment.

Intermediate-term dermal MOEs estimated for 8 handler scenarios using PHED data are all less than 100 at the baseline clothing and additional levels of PPE (MOEs ranged from 4 to 26). Engineering controls resulted in MOEs above 100 for only 2 of the 8 scenarios.

Intermediate-term inhalation MOEs estimated for 8 handler scenarios using PHED data are all less than 100 at the baseline PPE level (MOEs ranged from 8 to 31). The addition of a full face respirator resulted in intermediate-term inhalation MOEs above 100 for 6 scenarios assessed using PHED data. Risks for pilots applying liquids and granulars were only assessed with engineering controls; the MOEs were 89 and 3, respectively.

When intermediate-term dermal and inhalation risks are combined, the MOEs are less than 100 for all scenarios at baseline and when added protective clothing/PPE are added. When engineering controls are added, the MOEs are still less than 100 for pilots applying both granular and liquid formulations and for handlers applying both granular and liquid formulations using ground-based equipment and for handlers mixing/loading liquids for ground-based application.

Based on use pattern of molinate with rice (i.e. applied pre-plant, early post-emergent/pre-flood stage, and post flood), the exposure and risk from molinate during post-application activities is expected to be minimal. Workers entering flooded fields to perform scouting tasks will be wearing rubber boots. Also, hand-labor activities are not expected for rice. Thus, a quantitative exposure and risk assessment for post-application activities was not performed. Since the acute toxicity categories for the technical grade are III for oral and dermal, II for primary eye irritation, and IV for inhalation and primary skin irritation, the 24-hour restrictive entry interval (REI) that appears on molinate product labels is in compliance with the Agency's Worker Protection Standard (WPS).

The handler assessments are believed to be reasonable high end representations of molinate uses. There are, however, many uncertainties in these assessments. The uncertainties include but are not limited to the following:

- extrapolating exposure data by the amount of active ingredient handled or applied;

- not all of the exposure data are of high confidence because of the lack of replicates and/or inadequate QA/QC in the studies;

These uncertainties are inherent in most pesticide exposure assessments. The conservative nature of the assessments, however, are believed to be protective of the handlers and reentry workers.

2.0 Background Information

This memo was developed based on the information contained in the following referenced documents:

- **EPA MRID 40255201:** Knarr, R. (1987) Estimated Worker Exposure During Aerial Application of Ordram Selective Herbicide in Arkansas. Unpublished study prepared by Stauffer Chemical Company, 40p.

- **EPA MRID 42241501:** Chester, G.; Kolcun, J.; Boudreau, S. et al (1991) Molinate: Exposure of and Absorption by Workers Involved in Aerial Application of Ordram 15G to Rice Fields: Lab Project Number: TMF 3902. Unpublished study prepared by ICI Agro.-Fernhurst, UK; ICI, Alderly Park, UK. 279 p.

- **EPA MRID 43169101:** Chester, G.; Marsh, J.; Woolen, B. (1994) Molinate: Estimated Absorption Based Upon Urinary Excretion of 4-Hydroxy Molinate by Loaders Involved in the 1990 Exposure Study: Addendum to MRID 42561302: Lab Project Number: TMF 4191. Unpublished study prepared by Zeneca Agrochemicals, Central Toxicology Lab, 8p.

- **EPA MRID 43165601:** Curry, K.; Findlay, M.; Meyers, T. (1993) ORDRAM: Biological Monitoring of Persons Exposed to Molinate during Loading and Application (CA-1992): Lab Project Number MOLI-92-AE-01: TMR0533B. Unpublished study prepared by Western Research Center, Zeneca Ag Products; Zeneca Central Toxicology Laboratory, 50p.

- **EPA MRID 43165602:** Findlay, M.; Meyers, T. (1993) ORDRAM: Biological Monitoring of Persons Exposed to Molinate During Loading and Application (CA-1993): Lab Project Number MOLI-93-AE-01: RR088B. Unpublished study prepared by Western Research Center, Zeneca Ag Products; Zeneca Central Toxicology Laboratory, 86p.

- **EPA MRID 44212201:** Findlay, M. (1997) Molinate: Biological Monitoring of Workers During Loading of Arrosolo 3-3E into Airplane Hoppers: Final Report: Lab Project Number: MOLI-96-AE-01: RR-96-074B. Unpublished study prepared by Zeneca, Inc. 75p.

- Molinate end-use product labels include EPA Reg Numbers: 10182-420 (Ordram 15GM); 10182-171 (Ordram 6E); 10182-174 (Ordram 10G); 10182-204 (Ordram 8E); 10182-260 (Arrosolo 3-3E); and 10182-274 (Ordram 15-G). A manufacturing (technical) material label also exists as EPA Reg. No. 10182-275.

- Information presented at the September 23, 1998 Molinate SMART meeting between Zeneca Ag Products and the U.S. EPA Office of Pesticide Programs.

- EPA/HED memorandum: Evaluation of Study Entitled " Molinate : Biological Monitoring of Workers During Loading of Arrosolo 3-3E Into Airplane Hoppers" dated 3/12/97.

3.0 Occupational and Residential Exposure/Risk Characterization

Exposure data requirements are triggered based on the potential for exposure and the toxicological significance of the active ingredient. All non-dietary exposure/risk assessments completed for molinate are presented herein. Molinate has no residential uses so the only assessments that have been completed are for those who are occupationally exposed. Use patterns and available products are summarized in a manner appropriate for non-dietary risk assessment in **Section 3.1.** (Use Pattern/Available Product Summary For Exposure Assessment). The exposure/risk assessments that have been completed for each scenario, for which appropriate data exist, are included in **Section 3.2 (**Occupational Exposure/Risk Assessment). The characterization and summary of the results of each assessment are included in **Section 3.3** (Occupational Risk Characterization).

3.1 Use Pattern/Available Product Summary For Exposure Assessment

Molinate products are described in this section. Additionally, available information that describes the manner in which molinate products are applied is provided in this section (e.g., use categories/sites, application methods, and application rates).

3.1.1. End-Use Products

Molinate [S-ethyl hexahydro-1 H azepine-1-carbothioate], is a thiocarbamate herbicide that is marketed in a variety of end-use products. Molinate formulations include emulsifiable concentrate liquids and granulars. Table 1 summarizes all active end-use product formulations based on a review (4/22/98) of the *Office of Pesticide Programs -- Label Use Information System (LUIS), General Chemical Report:*

Table 1: Molinate Available Product Summary

Formulation Type	Percent Active Ingredient	EPA Reg. Numbers
Emulsifiable Concentrates	33.1 (3 lb ai/gal), 72.3 (6 lb ai/gal), & 90.0 (8 lb ai/gal)	010182-00171, 010182-00204, 010182-00260, CA77015900, CA84017200, CA85005300, TN93000600

Granulars (includes G & GM types)	10.0 & 15.0	010182-00174, 010182-00274, 010182-00420, CA78000400, CA85005400, TN 93000700 & TX81002501

Note: 010182-00260 (Arrosolo) also contains the herbicide, propanil at 33.1%
Note: a manufacturing product label (Reg. No. 10182-275) also exists at 96% ai
Note: Another registrant, RICECO, recently registered a molinate technical and two end-use products, a granular (15% a.i.) and a liquid (combination of molinate and propanil) formulation.

All products are registered for occupational use only. There are no products intended for sale to homeowners. Products are intended for application only to rice during different aspects of the growing season.

3.1.2. Mode of Action and Targets Controlled

Molinate is a thiocarbamate herbicide used for the control of various weed species in rice including barnyard grass, dayflower, sprangletop, and signalweed. Molinate is also used to reduce competition from red rice. Molinate is not registered on any other crop or site. The specific mechanism for the herbicidal activity of molinate is unknown.

3.1.3. Registered Use Categories and Sites

An analysis of the current labeling and available use information was completed using the *Office of Pesticide Programs -- Label Use Information System* (Report Date 4/22/98). This information indicates that molinate can be used on the following sites:

- ***Aquatic Food Crop:*** all EPA registration numbers described above in **Section 3.1.1.** are for rice only, application to flooded rice levees or dry rice levees is dependent on regional and grower variation in cultural practices.

- ***Terrestrial Food Crop:*** all EPA registration numbers described above in **Section 3.1.1.** are for rice only, application to flooded rice levees or dry rice levees is dependent on regional and grower variation in cultural practices.

3.1.4. Application Parameters & Cultivation Practices

Molinate use on rice differs based on cultural practices (e.g., wet versus dry seeding and water management). Application parameters are generally defined by the physical nature of the use site, by the equipment required to deliver the chemical to the use site, and by the application rate required to achieve efficacy. Molinate applications intended for weed control in rice are predominantly made by aircraft (approximately 90 percent of total applied) while the remaining applications are completed by ground-based equipment designed to apply granulars or by typical groundboom spray rigs. Most ground-based applications occur by pre-plant/incorporation. Information obtained at the September 1998 SMART meeting indicates molinate is apparently sold mostly in bulk packaging. This is supported by the fact that the predominant applicators are pilots who would use larger quantities of molinate compared to a typical grower (i.e., bulk packaging is easier to handle for larger quantity users).

The predominant rice producing states are Arkansas, California, Louisiana, Mississippi, Missouri, and Texas. Cropping time for rice ranges from approximately 120 to 140 days. In the southern states, usual planting times typically range from early to mid April through late May. In California, most planting is completed during May. Harvest in the southern states can range from the beginning of August through the end of October. Likewise, harvest in California essentially occurs throughout October. Rice cultivation practices can be illustrated by describing the differences between water-seeded rice and rice that is dry seeded. For the purposes of this discussion, drill seeded rice will serve as the basis for illustrating dry seeding practices. In dry seeded rice, a single flood stage is used that usually lasts from 85 to 110 days and ranges from the appearance of the 5th leaf to maturity. In this scenario, molinate appears to be used preplant, in the early post-emergent/pre-flood stage (Arrosolo only), and post-flood. In wet seeded rice, two flood stages are used. The first is the seeding flood stage that lasts only up to approximately a week after seeding. After the removal of the first flood waters, an interim dry stage occurs that is followed by a long duration flood stage that usually lasts from 85 to 110 days and ranges from the appearance of the 2nd or 3rd leaf to maturity. In this scenario, molinate appears to be used preplant, during the seeding flood, and early post-flood.

A discussion of molinate use practices as they relate to the cultivation of rice were presented by Zeneca at the September 1998 SMART meeting. Four distinct formulations were used to illustrate use patterns as these represent a majority of molinate use across the country (i.e., the agency has also used this approach in developing the RED risk assessment as the maximum rates for all similar formulations are the same -- e.g., the maximum rate for granular formulations is 5 lb ai/A regardless of whether a 10G or 15G is used). The four formulations that constitute the majority of molinate use (and also serve as the basis for this risk assessment) include: Arrosolo 3-3E (EPA Reg. No. 10182-260); Ordram 8E (EPA Reg. No. 10182-204); Ordram 15G (EPA Reg. No. 10182-274); and Ordram 15GM (EPA Reg. No. 10182-420). Since these formulations represent the majority of molinate use, they will serve as the basis for the risk assessment. Arrosolo 3-3E is typically used only in the south and is applied post-emergence, preflood to actively growing weeds in the 1-2 leaf stage. In the south, Ordram 8E is applied preplant/soil incorporation by ground equipment on dry-seeded rice. It is also used post-emergent/preflood on dry and water-seeded rice and post-emergence at flooding for dry-seeded rice. In California, Ordram 8E is applied preplant/preflood for water seeded rice and also post-flood/postemergence for both dry and water-seeded rice. Ordram 15G is apparently only used in the south. It can be used preplant/preflood and postflood/preplant on water seeded rice. It can also be used postflood/postemergent on both dry and water seeded rice. A minimum of 30 days is required between preplant and postflood applications for both Ordram 8E and Ordram 15G. Ordram 15GM is apparently used only in California. Ordram 15GM can be used preplant/soil incorporation on water-seeded rice. It can also be used postflood/post-emergent on both dry and water-seeded rice at the seedling stage. Three of the four formulations (Arrosolo is the exception) also have requirements for post application soil incorporation if the applications are made in the pre-flood stage.

3.1.5. Use Summary

A discussion of actual molinate use quantities as they relate to the cultivation of rice were presented by Zeneca at the September 1998 SMART meeting. This information is summarized below in Table 2.

Table 2: Molinate Use Summary Table

Use Parameter		Arrosolo 3-3E	Ordram 8E	Ordram 15G	Ordram 15GM
Application Rate (lb ai/A)	Maximum	3	4	5	5
	Typical	2.25	3	4	4
	Seasonal (Total)	9	6	9	9
Number of Applications (per/season)	Maximum	3	2	3	3
	Typical	2	2	2	2
packaging		30 gal and bulk (>100 gal)	15 and 30 gal	1500 and 500 lb bags	1200 and 500 lb bags

Note: Both EC formulations have a total combined maximum seasonal limit of 22,800 lb ai/worker.

3.2 Occupational Exposure/Risk Assessment

HED has determined that there is a potential for exposure from handling molinate products during the application process (i.e., mixer/loaders, applicators, flaggers, mixer/loader/applicators) and from entering agricultural areas previously treated with molinate. Occupational postapplication exposures, however, are expected to be minimal because of the nature of the activities associated with rice cultivation (e.g., scouting and water management) and the protective equipment that is commonly used during these activities (e.g., waterproof rubber boots for walking through rice paddies). HED has not addressed any residential exposure scenarios because there are no residential uses of molinate. As such, the exposure assessment process has focused only for occupational handler and postapplication scenarios.

3.2.1. Calculations/Endpoints Used in the Exposure/Risk Assessment

A series of toxicological endpoints and calculations were used to complete the handler and post-application risk assessments. The specifics for calculating handler and post-application exposures differ because of the way that data for each scenario are presented. As such, the endpoints and equations that have been used to calculate exposures/risks for all scenarios are presented in this section.

(i) Toxicological Endpoints

The endpoints that were used to complete this assessment are from 10/30/98 HIARC Report and summarized below in order to provide a quick reference to the occupational handler and postapplication assessments. The doses and toxicological endpoints selected for various exposure scenarios are summarized below.

EXPOSURE SCENARIO	DOSE (mg/kg/day)	ENDPOINT	STUDY
Acute Dietary	LOAEL = 1.8	Neurotoxic effects	Developmental Neurotoxicity
	UF = 300	**Acute RfD = 0.006 mg/kg**	
Chronic Dietary non-carcinogenic effects	LOAEL=0.3	Degeneration/demyelination	Rat Chronic Toxicity/Carcinogenicity
	UF=300	**Chronic RfD = 0.001 mg/kg/day**	
Carcinogenic [a] effects Dietary/Dermal	$Q^*_1 = 4.92\times10^{-2}$ $(mg/kg/day)^{-1}$	Male rat kidney tumors	
Short-Term[b] (Dermal)	Oral LOAEL = 1.8	Neurotoxic effects	Developmental Neurotoxicity
Intermediate-Term [b] (Dermal)	Oral NOAEL = 0.2	Male reproductive effects	5-week rat fertility
Long-Term (Dermal / Non-cancer)	None	The use pattern (1-2 applications per season to rice) does not indicate potential long-term dermal exposure; risk assessment is NOT required.	
Short-Term (Inhalation)	NOAEL = 0.12 mg/L [converted to 20.9 mg/kg/day by L. Taylor]	Hind-leg muscle weakness and testicular effects	Acute inhalation - rat
Intermediate-Term (Inhalation)	NOAEL = 0.0003 mg/mL [converted to 0.078 mg/kg/day by Linda Taylor]	Male reproductive effects	4-week inhalation - rat
Long-Term (Inhalation)	None	The use pattern (1-2 applications per season to rice) does not indicate potential long-term dermal exposure; risk assessment is NOT required.	

[a] This is a revised value using ¾ power. see HED memo from L. Brunsman (SAB) to V.Dobozy (RRB1) dated 11/18/99
[b] Since an oral LOAEL was selected a dermal absorption factor of 40% should be used for dermal risk assessments.

NOTE: For Short-term dermal risk assessments, MOE of 300 is required; MOE of 100 is adequate for all other exposure (dermal and inhalation) risks.

(ii) Handler Exposure/Risk

Handler exposure and risk was assessed using exposure data from **biological monitoring** studies. Scenarios not having adequate biological monitoring data were assessed using unit exposure values from the **Pesticide Handler Exposure Data Base (PHED)** Version 1.1 as presented in the PHED Surrogate Exposure Guide (August 1998).

For adult handlers using molinate, a body weight of 70 kg was used for all exposure scenarios because the endpoint is not sex-specific.

Handler Exposure Estimated Using Biological Monitoring Data

Urine samples from handlers were analyzed for 4-hydroxy molinate (corrected for the metabolite representing 39% of the dose and the molecular weight difference between the metabolite and molinate, see Appendix C). The handler's exposures were normalized to "mg ai / lb ai handled" and used with default body weights and anticipated application rates for handlers to estimate a daily dose as follows:

Daily Exposure (mg ai /day) = Unit Exposure (mg ai/lb ai) x Application Rate (lb ai handled/day)

$$\textbf{Daily Dose (mg ai /kg/day)} = \frac{\text{Daily Exposure (mg ai/day)}}{\text{Body Weight (kg)}}$$

Where:

Daily Exposure = Daily absorbed dose of molinate, also referred to as absorbed dose (mg ai/day);

Unit Exposure = Normalized exposure value derived from biological monitoring data (mg ai/lb ai handled);

Application Rate = Normalized application rate based on a logical unit treatment such as lb ai handled/day, a maximum value is generally used (lb ai/day); and

Handler Exposure Estimated Using PHED Data

When passive dosimetry results from PHED were used in this assessment, the daily dermal exposure, daily dose, and hence the risks, to handlers were calculated as described below. The first step was to calculate daily dermal exposure using the following formula:

Daily Dermal Exposure (mg ai/day) = Unit Exposure (mg ai/lb ai) x Application Rate (lb ai/A) x Daily Acres Treated (A/day)

Where:

Daily Dermal Exposure = Amount deposited on the surface of the skin that is available for dermal absorption, also referred to as potential dose (mg ai/day);

Unit Exposure = Normalized exposure value derived from August 1998 PHED Surrogate Exposure Table, chemical-specific handler data were available for this assessment and are noted as appropriate (mg ai/lb ai handled);

Application Rate = Normalized application rate based on a logical unit treatment such as acres/day, a maximum value is generally used (lb ai/A); and

Daily Acres Treated = Normalized application area based on a logical unit treatment such as acres (A/day).

Daily dermal dose was then calculated by normalizing the daily dermal exposure value by body weight and accounting for dermal absorption (i.e., a biologically available dose resulting from dermal exposure). A dermal absorption factor of 40 percent was used for all calculations. Daily dermal dose was calculated using the following formula:

$$Daily\ Dermal\ Dose \left(\frac{mg\ ai}{kg/day}\right) = Daily\ Dermal\ Exposure \left(\frac{mg\ ai}{day}\right) x \left(\frac{DermalAbsorptionFactor(\%/100)}{Body\ Weight\ (kg)}\right)$$

The next step was to calculate the daily inhalation dose for handlers. The process used is similar to that used to calculate the daily dermal dose to handlers. Daily inhalation exposure levels were are presented as (μg/lb ai) values in the PHED Surrogate Exposure Table of August 1998 (i.e., these values are based on an inhalation rate of 29 liters/minute and an 8 hour exposure interval). Once the unit exposure value is presented in this form and converted to (mg/lb ai), the calculations essentially mirror those presented above for the dermal route using a value of 100 percent absorption (i.e., a daily inhalation dose is calculated in mg/kg/day).

The handler exposure assessments that are based on data from PHED do not include any dietary or drinking water inputs.

Handler Risk Estimated Using Biological Monitoring Data

Available biological monitoring data was used to calculate total absorbed doses for 3 of 11 handler scenarios identified for molinate. The calculated total absorbed doses were compared to the selected short-term and intermediate-term toxicological endpoints of 1.8 mg/kg/day and 0.2 mg/kg/day respectively. Since the short-term dose of 1.8 mg/kg/day was based on a LOAEL, an additional 3x was added to the conventional 100 resulting in an uncertainty factor of 300. The intermediate-term dose is based on a NOAEL and has an uncertainty factor of 100. Comparison of the doses and endpoints results in a Margin of Exposure (MOE).   MOEs were calculated using the following formula:

$$\text{MOE} = \frac{\text{NOAEL or LOAEL}\left(\frac{\text{mg}}{\text{kg/day}}\right)}{\text{Daily Absorbed Dose}\left(\frac{\text{mg}}{\text{kg/day}}\right)}$$

For the 3 biological monitoring scenarios, calculated daily absorbed doses with a short-term MOEs $\geq$300 and intermediate-term MOEs $\geq$100 are below the Agency's level of concern.

Handler Risk Estimated Using PHED Data

Since adequate biomonitoring data were only usable for three scenarios, the other eight scenarios were evaluated using the unit exposures from the Pesticide Surrogate Exposure Guide (8/98).

Short- and intermediate-term risks were calculated for dermal, inhalation and the combined dermal and inhalation exposures. It was concluded that the dermal and inhalation exposures could be combined due to the common endpoint for short-term (neurotoxicity) and intermediate-term (reproductive effects) exposures. Since the short-term dermal endpoint was based on a LOAEL with an additional uncertainty factor of 3, the LOAEL was divided by 3 before calculating the combined short-term dermal and inhalation MOEs. The intermediate-term dermal and inhalation endpoints were both based on a NOAEL so this additional step was not necessary for the combined intermediate MOEs. The combined MOEs were calculated using the following equation:

$$\frac{1}{(1/\text{dermal MOE}) + (1/\text{inhalation MOE})}$$

A combined MOE of less than 100 exceeds the Agency's level of concern.

<u>Cancer Risks</u>

Cancer risks were calculated for the eleven scenarios using the Q^*_1 of 4.92×10^{-2} $(mg/kg/day)^{-1}$.

$$\text{Cancer Risk} = Q^* \,(mg/kg/day)^{-1} \times \text{LADD}\,(mg/kg/day)$$

To calculate lifetime average daily doses (LADDs), it was assumed that handlers work duration would be 35 years with a life expectancy of 70 years. <u>Typical application rates</u> (lb ai/A or lb ai handled/day) were used for LADDs. When PHED data were used, daily dermal doses and inhalation doses were added to estimate a the total daily dose (absorbed daily dose). The lifetime average daily dose (LADD) was calculated using the following formula:

$$LADD\left(\frac{mg}{kg/day}\right) = Daily\ Total\ Dose\left(\frac{mg}{kg/day}\right) x \left(\frac{days\ worked}{365\ days\ per\ year}\right) x \left(\frac{35\ years\ worked}{70\ year\ lifetime}\right)$$

Cancer risk was calculated using the following formula:

$$\text{Cancer Risk} = Q^* \,(mg/kg/day)^{-1} \times \text{LADD}\,(mg/kg/day)$$

A cancer risk of greater than 1.0×10^{-6} exceeds HED's level of concern for the general population. For occupational exposures, HED's level of concern is exceeded when cancer risks greater than 1.0×10^{-4}.

Post-Application Exposure/Risk: Based on use pattern of molinate with rice (i.e. applied pre-plant, early post-emergent/pre-flood stage, and post flood), the exposure and risk from molinate during post-application activities is expected to be minimal. Workers entering flooded fields to perform scouting tasks will be wearing rubber boots. Also, hand-labor activities are not expected for rice. Thus, a quantitative exposure and risk assessment for post-application activities was not performed.

Since the acute toxicity categories for the technical grade are III for oral and dermal, II for primary eye irritation, and IV for inhalation and primary skin irritation, the 24-hour restrictive entry interval (REI) that appears on molinate product labels is in compliance with the Agency's

Worker Protection Standard.

3.2.2. Data Sources For Handler Risk Assessment

The non-dietary exposure database that has been developed in support of the reregistration of molinate is extensive when compared to that for other similar chemicals. This database contains exposure monitoring data that have been developed using both passive dosimetry and biological monitoring techniques. A molinate-specific epidemiology assessment has also been completed. HED policy dictates that chemical-specific data be used in conjunction with other sources of exposure data commonly used by HED to complete risk assessments (e.g., *Pesticide Handlers Exposure Database*). As such, several data sources were considered in this assessment including the *Pesticide Handlers Exposure Database* (PHED) and the array of molinate-specific data have been submitted. Brief descriptions of the specific exposure data that have been used in this assessment are presented below.

When molinate-specific handler exposure data for various scenarios were not available or when such data were available and were used in conjunction with existing sources of data, the exposure assessment was developed using PHED (V1.1). PHED data were used to complete an assessment only for those scenarios where the surrogate data were deemed appropriate by HED. PHED was designed by a task force of representatives from the U.S. EPA, Health Canada, the California Department of Pesticide regulation, and member companies of the American Crop Protection Association. PHED is a software system consisting of two parts -- a database of measured exposure values for workers involved in the handling of pesticides under actual field conditions and a set of computer algorithms used to subset and statistically summarize the selected data. Currently, the database contains values for over 1,700 monitored individuals (i.e., replicates)

Users select criteria to subset the PHED database to reflect the exposure scenario being evaluated. The subsetting algorithms in PHED are based on the central assumption that the magnitude of handler exposures to pesticides are primarily a function of activity (e.g., mixing/loading, applying), formulation type (e.g., wettable powders, granulars), application method (e.g., aerial, groundboom), and clothing scenarios (e.g., gloves, double layer clothing).

Once the data for a given exposure scenario have been selected, the data are normalized (i.e., divided by) by the amount of pesticide handled resulting in standard unit exposures (milligrams of exposure per pound of active ingredient handled). Following normalization, the data are statistically summarized. The distribution of exposure values for each body part (e.g., chest upper arm) is categorized as normal, lognormal, or "other" (i.e., neither normal nor lognormal). A central tendency value is then selected from the distribution of the exposure values for each body part. These values are the arithmetic mean for normal distributions, the geometric mean for lognormal distributions, and the median for all "other" distributions. Once selected, the central tendency values for each body part are composited into a "best fit" exposure value representing the entire body.

The unit exposure values calculated by PHED generally range from the geometric mean to the median of the selected data set. To add consistency and quality control to the values produced from this system, the PHED Task Force has evaluated all data within the system and has developed a set of grading criteria to characterize the quality of the original study data. The assessment of data quality is based on the number of observations and the available quality control data. These evaluation criteria and the caveats specific to each exposure scenario are summarized in **Table 14.** While data from PHED provide the best available information on handler exposures, it should be noted that some aspects of the included studies (e.g., duration, acres treated, pounds of active ingredient handled) may not accurately represent labeled uses in all cases. HED has developed a series of tables of standard unit exposure values for many occupational scenarios that can be utilized to ensure consistency in exposure assessments.

There are three basic risk mitigation approaches considered appropriate for controlling occupational exposures. These include administrative controls, the use of personal protective equipment or PPE, and the use of engineering controls. Occupational handler exposure assessments are completed by HED using a baseline exposure scenario and, if required, increasing levels of risk mitigation (PPE and engineering controls) to achieve an appropriate margin of exposure or cancer risk. [Note: Administrative controls available generally involve altering application rates for handler exposure scenarios. These are typically not utilized for completing handler exposure assessments because of the negotiation requirements with registrants.] The baseline clothing/PPE ensemble for occupational exposure scenarios is generally an individual wearing long pants, a long-sleeved shirt, no chemical-resistant gloves (there are exceptions pertaining to the use of gloves and these are noted), and no respirator. The first level of mitigation generally applied is PPE. As reflected in the calculations included herein, PPE involves the use of an additional layer of clothing, chemical-resistant gloves, and a respirator. The next level of mitigation considered in the risk assessment process is the use of appropriate engineering controls which, by design, attempt to eliminate the possibility of human exposure. Examples of commonly used engineering controls include closed tractor cabs, closed mixing/loading/transfer systems, and water-soluble packets.

Several molinate-specific exposure studies were submitted to support reregistration. These studies were generated to quantify the exposures of occupational handlers using biological monitoring and passive dosimetry techniques and to assess the effects of molinate on a population of molinate production workers through an epidemiological analysis. The use of specific data sources is noted as appropriate in the text and in the exposure assessment tables. The chemical-specific studies submitted to support the reregistration of molinate can be identified by the following information:

- **EPA MRID 40255201:** Knarr, R. (1987) Estimated Worker Exposure During Aerial Application of Ordram Selective Herbicide in Arkansas. Unpublished study prepared by Stauffer Chemical Company, 40p.

- **EPA MRID 43165601:** Curry, K.; Findlay, M.; Meyers, T. (1993) ORDRAM: Biological Monitoring of Persons Exposed to Molinate during Loading and Application (CA-1992): Lab Project Number MOLI-92-AE-01: TMR0533B. Unpublished study prepared by Western Research Center, Zeneca Ag Products; Zeneca Central Toxicology Laboratory, 50p.

- **EPA MRID 43165602:** Findlay, M.; Meyers, T. (1993) ORDRAM: Biological Monitoring of Persons Exposed to Molinate During Loading and Application (CA-1993): Lab Project

Number MOLI-93-AE-01: RR088B. Unpublished study prepared by Western Research Center, Zeneca Ag Products; Zeneca Central Toxicology Laboratory, 86p.

- **EPA MRID 43169101:** Chester, G.; Marsh, J.; Woolen, B. (1994) Molinate: Estimated Absorption Based Upon Urinary Excretion of 4-Hydroxy Molinate by Loaders Involved in the 1990 Exposure Study: Addendum to MRID 42561302: Lab Project Number: TMF 4191. Unpublished study prepared by Zeneca Agrochemicals, Central Toxicology Lab, 8p.

- **EPA MRID 44212201:** Findlay, M. (1997) Molinate: Biological Monitoring of Workers During Loading of Arrosolo 3-3E into Airplane Hoppers: Final Report: Lab Project Number: MOLI-96-AE-01: RR-96-074B. Unpublished study prepared by Zeneca, Inc. 75p.

- **EPA MRID 42241501:** Chester, G.; Kolcun, J.; Boudreau, S. et al (1991) Molinate: Exposure of and Absorption by Workers Involved in Aerial Application of Ordram 15G to Rice Fields: Lab Project Number: TMF 3902. Unpublished study prepared by ICI Agro.-Fernhurst, UK; ICI, Alderly Park, UK. 279 p.

- **EPA MRID 425613-02:** Chester, G.; Marsh, J.R.; Woollen, B.H. (1992) Molinate: Estimated Absorption Based Upon Urinary Excretion of 4-Hydroxy Molinate by Loaders involved in the 1990 Arkansas Exposure Study. Lab Project Number: TMF 4191. Unpublished study prepared by ICI Agro.-Fernhurst, Central Toxicology Laboratory, UK; ICI Americas, Inc., Wilmington, Delaware, 30 p.

- **EPA MRID 425823-01:** Lythgoe, RE.; Jones, BK.; Macpherson, D. (1992) Molinate: Excretion and Blood Kinetics in the Monkey. Lab Project Number: CTL/L/4432. Unpublished study prepared by Stauffer Chemical Company, Environmental Health Center, Connecticut & ICI Central Toxicology Laboratory, UK; ICI Americas, Inc., Wilmington, Delaware.

- **EPA MRID 425823-02:** Batten, PL.; Woollen, BH.; Loftus, NJ.; Marsh, (1992) Molinate: Metabolism in Man Following a Single Oral Dose. Study Number: XH2006. Unpublished study prepared by ICI Central Toxicology Laboratory, UK; ICI Americas, Inc., Wilmington, Delaware.

These studies have been reviewed by the Agency in phases over several years. The reviews indicate that some of these studies were considered acceptable to the Agency based on the review criteria appropriate of the era and that technical inadequacies were identified in several of the studies. Reviews of each specific MRID are identified below and can be cross referenced to the submission documents by MRID number.

- **EPA MRID 40255201:** No formal review focused on the regulatory acceptability of this study could be identified. This study, however, has been summarized and reviewed for other purposes since submitted. Therefore, a summary regulatory review has been incorporated into this document.

- **EPA MRID 43165601:** *Molinate Worker Exposure Studies Conducted in California Rice Growing Areas (Sacramento Valley) in May 1992 and June 1993* A memo from Bruce Kitchens of the former Occupational and Residential Exposure Branch of HED to Lisa Engstrom, Special Review and Reregistration Division (May 20, 1994).

- **EPA MRID 43165602:** *Molinate Worker Exposure Studies Conducted in California Rice Growing Areas (Sacramento Valley) in May 1992 and June 1993* A memo from Bruce Kitchens of the former Occupational and Residential Exposure Branch of HED to Lisa Engstrom, Special Review and Reregistration Division (May 20, 1994).

- **EPA MRID 43169101:** No formal review focused on the regulatory acceptability of this study could be identified. This study, however, has been summarized and reviewed for other purposes since submitted. Therefore, a summary regulatory review has been incorporated into this document.

- **EPA MRID 44212201:** *Evaluation of Study Entitled "Molinate: Biological Monitoring of Workers During Loading of Arrosolo 3-3E Into Airplane Hoppers* A memo from Leo Lasota of the former Occupational and Residential Exposure Branch of HED to Michael Metzger, Chief of the former Risk Characterization and Analysis Branch of the Health Effects Division (March 12, 1997).

- **EPA MRID 42241501:** *Review of Study Entitled: Molinate; Exposure of and Absorption by Workers Involved in Aerial Application of Ordram 15G to Rice Fields* A memo from Bruce Kitchens of the former Occupational and Residential Exposure Branch of HED to Jack Housenger, Chief of the Special Review Branch, of the Special Review and Reregistration Division (March 17, 1994).

- **EPA MRID 425613-02:** *Molinate: Estimated Absorption Based on Urinary Excretion of 4-Hydroxy Molinate* A memo from Linda L. Taylor, formerly of the Toxicology II Branch of HED to Kathy Davis, Section Chief of the Accelerated Reregistration Branch, of the Special Review and Reregistration Division (October 1, 1993).

- **EPA MRID 425823-01:** *Molinate: Excretion and Blood Kinetics in the Monkey* A DER (Data Evaluation Record) from Linda L. Taylor, formerly of the Toxicology II Branch of HED (April 5, 1994).

- **EPA MRID 425823-02:** *Molinate: Metabolism in Man Following a Single Oral Dose* A DER (Data Evaluation Record) from Linda L. Taylor, formerly of the Toxicology II Branch of HED (April 5, 1994).

In order to develop a transparent exposure/risk assessment and facilitate the use of the data, all of the chemical-specific exposure data have been summarized by categorizing the data based on exposure scenario and regional differences. These categorizations will be used throughout this exposure/risk assessment to facilitate the use of the data. The categorizations include:

- **Ordram 8E Aerial Application in Arkansas (1987) and Ordram 10G Aerial Application in Arkansas (1987):** Data pertaining to this exposure study are included in MRID 40255201.

- **Ordram 15G Aerial Application in Arkansas (1990):** Data pertaining to this exposure study are included in MRIDs 43169101, 42241501, and 42561302. MRID 42241501 contains the original study while MRIDs 43169101 and 42561302 include addenda to the original report. It should be noted that in the original study, the urinary metabolite screened for was deemed inappropriate because of dose response issues and that the addenda present data generated from re-analysis of urine samples from the original study.

- **Ordram 10G & 10GM Aerial Application in California (1992 & 1993):** Data pertaining to this exposure study are included in MRIDs 43165601 and 43165602.

- **Loading Arrosolo 3-3E Into Airplane Hoppers (1997):** Data pertaining to this exposure study are included in MRID 44212201.

- **Human Pharmacokinetic Database:** Data pertaining to this database are included in MRIDs 425823-01 and 425823-02.

The following is a detailed summary of the data extracted from the worker exposure studies that were submitted for molinate:

[1] MRID# **40255201**: Estimated Worker Exposure During Aerial Application of Ordam in Arkansas

In May and June, **1980** worker exposure was monitored during the loading and application of Ordam 10G (granular 10% ai) at 3 to 5 lb ai/A and for Ordam 8E (liquid 90% ai) at 1 lb ai/A (MRID# **40255201**, Estimated Worker Exposure During Aerial Application of Ordam in Arkansas). Air samples were taken in the breathing zone of workers, using portable sampling pumps with glass XAD-2 solid sorbent resin tubes. Hand exposure was measured using ethanol hand washes. Durham and Wolfe-type patch dosimeters (4"x 4" gauze pads) were attached to exterior of the worker's coveralls (both forearms, both shoulders, both thighs, right chest, left back). Patches were also attached inside the coveralls on the chest and back so that a amount of penetration through clothing could be estimated.

The data from this study were entered in the Pesticide Handler Exposure Database (PHED version 1.1). Unit exposures for the 1980 study have been extracted from PHED and are summarized in **Table 3** (Appendix A contains tables with unit exposure data by body part).

Table 3 - MRID#40255201: Estimated Worker Exposure During Aerial Application of Ordam in Arkansas

Exposure Scenario	# of workers sampled	unit exposures from patch data and air samples			
		single layer no gloves		single layer, coveralls, gloves	
		Dermal (μg/lb ai handled)	Inhalation (μg/lb ai handled)	Dermal (μg/lb ai handled)	Inhalation (μg/lb ai handled)
Mixing/Loading Liquids	8	73.78	3.52	36.45	3.52
Mixing/Loading Granulars	8	11.88	17.43	6.23	17.43
Pilots Applying Liquids	3	1.51	0.61	-	-
Pilots Applying Granulars	4	1.77	0.79	-	-
Flaggers - Liquid	4	88.89	2.07	61.10	2.07
Flaggers - Granular	4	2.89	0.15	1.75	0.15

[2] MRID# **42241501:** Molinate: Exposure of and Absorption by Workers involved in Aerial Application of Ordam 15G to Rice Fields

In **1990**, a worker exposure study was conducted in Arkansas for workers applying Ordam 15G to rice fields at a rate of 4.1 lb ai/A (MRID# **42241501**, Molinate: Exposure of and Absorption by Workers involved in Aerial Application of Ordam 15G to Rice Fields). The study was conducted under conditions intended to "simulate" those conditions typically incurred in California. Mixer/loaders were sampled for two scenarios: the loading of 50-lb bags and for the loading of 1,500-lb bags. Flaggers and Pilots were also monitored.

Handlers' dermal exposures were measured using whole body dosimeters. Inhalation exposures were measured by taking air samples in the breathing zone of handlers. Biomonitoring of loaders' urine for molinate's's major metabolite, 4-hydroxy molinate's was also conducted. Flaggers and Pilots urine was not sampled.

In March 1994, HED reviewed the study and concluded that it **did not** meet the Agency's Subdivision U Pesticide Assessment Guidelines 231 and 232 (HED memo to SRRD dated 2/17/94, Review of Study Entitled: Molinate; Exposure of and Absorption by Workers involved in Aerial Application of Ordam 15G to Rice Fields). In 1996, Subdivision U was revised as Series 875-Occupational and Residential Exposure Test Guidelines, Group A-Applicator Exposure Monitoring Test Guidelines.

The whole body dosimetry and air sampling data from this study **were entered in the Pesticide Handler Exposure Database** (PHED version 1.1). Unit exposures for the 1990 study have been extracted from PHED and are summarized in **Table 4** (Appendix B contains tables with unit exposure data by body part). Biomonitoring results for the loaders are also summarized in table 4 (right column).

Table 4. MRID# **42241501:** Molinate: Exposure of and Absorption by Workers involved in Aerial Application of Ordam 15G to Rice Fields

Exposure Scenario	# of workers monitored	lb ai handled[1]	Body weight [1] (kg)	unit exposures from whole body dosimeters and air sampling				Unit exposures from Biomonitoring [2] (μg/kg/day)
				single layer with gloves		single layer, coveralls, gloves		
				Dermal (μg/lb ai handled)	Inhalation (μg/lb ai handled)	Dermal (μg/lb ai handled)	Inhalation (μg/lb ai handled)	
Loading Granulars (50-lb bags)	12	2,863	89	15.58	8.01	8.65	8.01	711
Loading Granulars (1,500-lb bags)	10	3,788	82	6.48	7.99	4.47	7.99	450
Pilots Applying Granulars	9			2.37	1.66	-	-	-
Flaggers -Granular	16			2.80	-	1.74	-	-

[1]arithmatic mean
[2]geometric mean

[3] EPA MRID# **431656-01**: Ordam: Biological Monitoring of Persons Exposed to Molinate During Loading and Application [CA-1992]

In May **1992**, workers' molinate's exposure were monitored in Sacramento valley, California during the loading of Ordam10G for aerial application on rice (EPA MRID# **431656-01**, Ordam: Biological Monitoring of Persons Exposed to Molinate During Loading and Application [CA-1992]). This study involved the original kaolin clay based 10G formulation. Two loading techniques were used: "direct-loading" and "trans-loading." Direct-loading involved workers loading bulk containers (1,500 lb bags) directly into an airplane hoppers, whereas trans-loading consisted of workers loading the bulk containers in addition to loading 50-lb bags into a container and then into the airplane hopper. It was reported that workers wore Tyvek suits, full face respirators, a tightly woven head covering, gloves, foot coverings, and boots. A total of 20 workers were monitored. Each worker was monitored for 3 days of exposure and one day of pre-exposure as baseline. Attempts were made to assure the workers were not exposed to molinate's the day before the exposure day started (baseline day), but the report indicates that workers did handle molinate on the "baseline day." A total of 20 workers were monitored and their work activities were classified in the following categories:

- two direct-loading drivers
- three trans-loading drivers
- three direct-loaders
- ten trans-loaders

Air samples were taken in the breathing zone of workers, using portable sampling pumps with glass XAD-2 solid sorbent resin tubes.

Urine samples were taken and analyzed for 4-hydroxy molinate (corrected for the metabolite representing 39% of the dose and molecular weight difference between the metabolite and molinate) . Twenty four hour urine samples were taken from each worker starting on the morning of the pre-exposure day and repeated at the beginning of each day until twenty four hours after the last exposure day. Human oral studies indicate that of the majority of molinate absorbed in the body is eliminated within twenty four hours of exposure.

It was reported that the majority of workers did not wear clean chemical resistant suits every day and in some cases the same suit was worn for the entire study. The individuals conducting the study reported that workers wore full face respirators when loading, but did not see them change the filters. Furthermore, it was unclear as to how long the filters had been in use.

Use permit deviations which include loading both bulk (1,500-lb) and small (50-lb) bags, and workers not wearing respirators or gloves during loading did occur. A summary of the exposures measured when workers were in compliance with most permit condition requirements are included as **Table 5.**

Table 5. - EPA MRID# **431656-01**: Ordam: Biological Monitoring of Persons Exposed to Molinate During Loading and Application [CA-1992]

Exposure Scenario	number of workers	lbs handled[1]	Daily Dose[1] (μg/kg/day)	Inhalation exposure[1] ($\mu g/m^3$)
Drivers Direct loading	2	0	0.0016	2.45
Drivers Trans Loading	5	14,410	0.0031	19.7
Loaders Direct loading	3	28,500	0.0056	22.6
Loaders Trans Loading	10	39,265	0.014	118

[1]arithmatic mean (as reported in the study report)

[4] EPA MRID# **431656-02** Ordam: Biological Monitoring of Persons Exposed to Molinate During Loading and Application [CA-1993]

In May and June of 1993, worker exposure were monitored by M. Findlay *et. al*. in Sacramento Valley, California during the loading of Ordam10G (granular formulation) for aerial application on rice (EPA MRID# **431656-02** Ordam: Biological Monitoring of Persons Exposed to Molinate During Loading and Application [CA-1993]). This study involved the new montmorillonite clay formulation that acts to stabilize and decrease molinate vaporization. During the study bulk bags (1,280 lbs) were loaded using two methods: direct-loading and trans-loading.

The study evaluated the effects of PPE and engineering controls as required under the 1993 California permit. The permit required PPE which consisted of a full face respirator, protective gloves, foot coverings, boots, either Tyvek® or carbon impregnated coveralls. The carbon impregnated coveralls were worn under normal work clothing. Four commercial aerial co-operators were used in the study, but no exposure results were reported for them. A total of 44 subjects were monitored and their work activities were classified in the following categories:

- ten loaders direct-loading wearing Tyvek® suits
- nine loaders direct-loading wearing carbon impregnated suits
- nine loaders both direct and trans-loading wearing Tyvek® suits
- six loaders both direct and trans-loading wearing carbon impregnated suits
- five drivers wearing no protective suits

- five drivers wearing carbon suits

Excluding the collection, moving, and recycling of empty bags, workers reportedly wore all the PPE required under the permit conditions. Coveralls worn by workers were either Tyvek or carbon impregnated suits.

Urine samples collected from the 44 workers were monitored over a four day period. The four days consisted of a baseline or pre-exposure-day followed by three additional days with at least one day in which a minimum of four 1280-lb bags were loaded. A 24-hour urine sample was collected from each worker each monitoring day. The 24-hour period was from the first void of the day, starting on the baseline or pre-exposure-day to the first void of the following day.

Ideally, no exposure to molinate would have occurred prior to the 4-day monitoring period or on the baseline day, but due to commercial practices of aerial applicators this was not always possible. In several cases, a baseline or pre-exposure without any loading of Ordam could not be obtained. It was also intended that workers would be loading on day 1, and where this was not possible the first became the baseline or pre-exposure day and the monitoring period was extended one day. The sum of molinate measured in the urine for days 1, 2, 3, and 20% of day 3 was calculated as the total dose for the study period. Human studies have shown that 80% of molinate is excreted in the first 24 hours. Since molinate was handled on day 3 for several loaders, and no urine samples were taken after day 3, 20% of day 3 was also added to account for molinate not yet excreted.
A summary of the exposure data from the 1993 study is included as **Table 6.** Appendix **C** contains a more detailed assessment of the exposure data from the 1993 study.

Table 6. MRID# **431656-02** Ordam: Biological Monitoring of Persons Exposed to Molinate During Loading and Application [CA-1993]

Exposure Scenario	PPE	# of workers monitored	body weight [1] (kg)	lb ai handled [1]	Daily Dose [2] (μg/kg/day)	Unit Exposure [2] (μg/lb ai handled)
Direct Loading	Tyvek	10	95.0	2797	6.15	0.676
	Carbon	9	94.7	1927	2.75	0.469
Direct and Trans Loading	Tyvek	9	90.1	2462	6.46	0.839
	Carbon	6	85.7	3264	11.63	0.948
Drivers	None	5	82.7	-	0.81	-
	Carbon	5	81.0	-	0.59	-

[1]arithmatic mean
[2]geometric mean

[5] EPA MRID# **442122-01** Molinate's: Biological Monitoring of Workers During Loading of Arrosolo 3-3E into Airplane Hoppers [Ark-1996]

In April and May of **1996,** Zeneca Ag Products conducted a worker exposure study involving the mixing and loading of Arrosolo 3-3E into airplane hoppers in north east Arkansas, approximately 80 miles south and 30 miles west of Jonesboro. Arrosolo 3-3E is a liquid formulation that contains 3 lbs of molinate per gallon. The product was loaded into the airplane either by direct metering from a bulk tank or 30-gallon drums, or by measuring into an open pre-mix tank.

Three different levels of PPE were evaluated:

Level 1: Activated carbon suit worn underneath Kleenguard coveralls , chemical resistant gloves, half-face respirator, chemical resistant footwear.

Level 2: Kleenguard coveralls worn over normal work clothing, chemical resistant gloves, half-face respirator, chemical resistant footwear

Level 3: Normal work clothing, recommended as long sleeved shirt, long pants, chemical resistant gloves, half-face respirator, chemical resistant footwear

The mixer/loader operations were performed by either one, two, or three workers using various combinations of open or closed delivery systems while handling unequal amounts of product. This resulted in insufficient replication, despite the fact that 19 workers were monitored.

For each level of PPE, urine samples were collected from subjects over a 4 day period: pre-day (day 1), exposure day (day 2), and 2 post application days (day 3 and 4) . Nineteen workers were monitored for level 1, and 17 for levels 2 and 3.

In 1997 HED recommended that the submitted report be considered a field survey of molinate absorption by mixer/loaders of aerially applied Arrosolo 3-3E, rather than a controlled study meeting all requirements of Section U Guidelines 133-4 (Inhalation Exposure) and 235 (Biological Monitoring). In 1996, Subdivision U was revised as Series 875-Occupational and Residential Exposure Test Guidelines, Group A-Applicator Exposure Monitoring Test Guidelines. Numerous problems in the conduct of the study make it impossible to determine, with confidence, the magnitude of exposure protection afforded by the different levels of personal protection equipment (PPE) worn in the study.

A summary of the handler exposure data in the study normalized to "μg of molinate in the urine per lb of ai handled is summarized in **Table 7.** Appendix **D** contains a more detailed assessment of the exposure data from the 1996 study.

Table 7. EPA MRID# **442122-01:** Molinate's: Biological Monitoring of Workers During Loading of Arrosolo 3-3E into Airplane Hoppers [Ark-1996]

Task	PPE	lb ai handled	μg molinate in urine/ lb ai handled[1]	mg/kg/day[2]
Mixing/ Loading Arrosolo 3-3E (liquid)	Normal Clothing (Level 3)	750	3.398	0.0284
	Kleenguard over normal clothing (Level 2)	857	1.167	0.0111
	Activated Carbon under Kleenguard (Level 1)	839	0.756	0.0072

[1]Geometric mean
[2] Geometric mean. Individual body weights were used

3.2.3. Handler Risk Assessment Assumptions and Factors

A series of assumptions and exposure factors served as the basis for completing the handler risk assessment. The following assumptions and factors were used in order to complete this assessment:

- Average body weight of an adult handler is 70 kg. This body weight is used in all assessments.

- The number of application days/year, the amount of ai/handled per day by loaders and areas treated/day were defined for each handler scenario.

  For aerial applications, the following assumptions were used and are based on information provided to the HED during the SMART meeting on 9/23/98, subsequent conversations with Zeneca, and the best professional judgement of the HED.

* aerial applications of granulars:	27 application days/year with average of 300 acres treated /day
* aerial applications of liquids:	27 application days/year with average of 300 acres treated /day
* loading granulars for aerial applications:	1,680 lb ai handled/day (average in 1993 study MRID# **431656-02** was approximatley 900 lb ai handled/day)
* mixing/loading liquids for aerial applications:	900 lb ai handled/day (average in 1996 study MRID# **442122-01** was approximatley 300 lb ai handled/day)

  No information on the number of application days/year for ground-based applications was provided to HED. Therefore, HED assumed that ground-based applications for liquid or granular formulations could occur for 30 application days/year.

- All short-term and intermediate-term handler calculations were completed at the maximum labeled application rate for each scenario.

- To calculate lifetime average daily doses (LADDs), it was assumed that handlers work duration would be 35 years with a life expectancy of 70 years. <u>Typical application rates</u> (lb ai/A or lb ai handled/day) were used for LADDs.

3.2.4. Occupational Handler Exposure/Risk Assessment

HED has determined that exposure to pesticide handlers is likely during the occupational use of molinate in the support of rice production. There are no apparent homeowner handler or application scenarios. The anticipated use patterns and current labeling indicate 11 major occupational exposure scenarios based on the types of equipment and techniques that can potentially be used to make molinate applications. These 11 scenarios serve as the basis for the quantitative exposure/risk assessment developed for occupational handlers. These scenarios include:

(1) loading granulars for aerial applications;
(2) truck drivers supporting loading granulars for aerial applications;
(3) pilots applying granulars using aerial equipment;
(4) flagging during aerial application of granulars;

(5) mixing/loading liquids for aerial applications;
(6) pilots applying liquids using aerial equipment;
(7) flagging during aerial application of liquids;

(8) loading granulars for ground-based applications;
(9) applying granulars using ground-based equipment;

(10) mixing/loading liquids for ground-based applications;
(11) applying liquids using ground-based equipment;

HED anticipates that occupational molinate exposures will only occur in a short-term or intermediate-term pattern. HED anticipates that occupational exposures will not be chronic because HED defines chronic exposures as use of the chemical for approximately 180 days per year and it is anticipated that molinate as with other typical pesticide compounds will not be used in this manner.

(i) Estimating Exposure and Risk Using Biomonitoring Exposure Data

Exposure and risk for the three mixer/loading scenarios [(1)loading granulars for aerial applications; (2) truck drivers supporting loading granulars for aerial applications; (5) mixing/loading liquids for aerial applications] were evaluated using biomonitoring exposure data from MRID# **442122-01** and EPA MRID# **431656-02** .

(1) loading granulars for aerial applications

The unit exposure data from the 1993 study, (EPA MRID# **431656-02** Ordam: Biological Monitoring of Persons Exposed to Molinate During Loading and Application), was used as the basis for estimating exposure for handlers loading granular formulations. Calculations of exposure and risk were based on the assumption that loaders are using bulk bags and are wearing long sleeve shirt, long pants, coveralls (Tyvek or carbon), and a full face respirator.

Table 8 includes MOEs and cancer risks for the handlers in the 1993 study. The short-term MOEs for the direct loaders in 1993 study was 290 for those wearing Tyvek suits and 660 for those wearing carbon suits. When workers did both loading methods (direct and trans) the short term MOEs for loaders wearing Tyvek and carbon were 280 and 160. Intermediate-term MOEs calculated for the loaders in the study range from 17 to 73. Cancer risks calculated for the loaders in the study range from 1.1×10^{-5} to 5.0×10^{-6}.

Table 8 also includes the MOEs using the unit exposures from the study normalized to mg/lb ai handled with 1,680 lb ai handled/day rate and a body weight of 70 kg. Short-term MOEs for loaders calculated using these parameters range from 80 to 160. Intermediate-term MOEs calculated range from 9 to 18. Cancer risks calculated (using average 900 lb ai/day rate to calculate lifetime average daily dose) for the loaders using there inputs range from 1.1×10^{-5} to 2.2×10^{-5}.

(2) truck drivers supporting loading granulars for aerial applications

As shown in **Table 8**, the short-term MOEs for the truck drivers supporting the loading of granulars for aerial applications in the 1993 study are 2,200 for those wearing no suits and 3,000 for those wearing carbon suits. Cancer risks calculated for drivers wearing no suits and those wearing carbon suits are 1.1×10^{-6} and 1.5×10^{-6}, respectively.

(5) mixing/loading liquids for aerial applications

Unit exposures from 1996 exposure study involving Arrosolo 3-3E (EPA MRID# **442122-01** Molinate's: Biological Monitoring of Workers During Loading of Arrosolo 3-3E into Airplane Hoppers) were used for the risk assessment of loaders.

The 3 different levels of PPE evaluated were:

Level 1: Activated carbon suit worn underneath 'Kleenguard' coveralls
Level 2: 'Kleenguard' coveralls worn over normal work clothing
Level 3: Normal work clothing, recommended as long sleeved shirt and long pants

Table 9 includes MOEs and cancer risks for the handlers in the 1996 study. The short-term MOEs for the mixer/loaders in PPE Levels 1, 2, and 3 are 250, 162, and 63, respectively. Intermediate-term MOEs calculated for the PPE Levels 1, 2, and 3 are 28, 18, and 7, respectively. Cancer risks calculated for the PPE Levels 1, 2, and 3 are 1.2×10^{-5}, 1.8×10^{-5}, 4.8×10^{-5}, respectively.

Table 9 also includes the MOEs using the unit exposures from the study normalized to mg/lb ai handled with 900 lb ai/day rate and a body weight of 70 kg. The short-term MOEs for the mixer/loaders in PPE Levels 1, 2, and 3 are 184, 120, and 41, respectively. Intermediate-term MOEs calculated for the PPE Levels 1, 2, and 3 are 20, 13, and 5, respectively. Cancer risks (using average 300 lb ai/day rate to calculate lifetime average daily dose) calculated for the PPE Levels 1, 2, and 3 are 5.4×10^{-6}, 8.4×10^{-6}, 2.5×10^{-5}, respectively.

Estimating Exposure and Risk Using Unit Exposures from PHED

Since adequate biomonitoring data was only usable for the three scenarios, the other eight scenarios [(3) pilots applying granulars using aerial equipment; (4) flagging during aerial application of granulars; (6) pilots applying liquids using aerial equipment; (7) flagging during aerial application of liquids; (8) loading granulars for ground-based applications; (9) applying granulars using ground-based equipment; (10) mixing/loading liquids for ground-based applications; and (11) applying liquids using ground-based equipment] were evaluated using the unit exposures from the Pesticide Surrogate Exposure Guide (8/98).

Table 10 presents the dermal and inhalation unit exposures for each occupational handler exposure scenario at all levels of mitigation (i.e., baseline, use of personal protective clothing, and engineering controls). [Note: There are no currently registered homeowner uses of molinate.] Also included in Table 10 are the application parameters that are used including application rates and areas treated for each exposure scenario.

Table 11 presents the non-cancer risks at the baseline exposure level (e.g., long pants, long-sleeved shirts, chemical-resistant gloves -- with exceptions as noted due to the available empirical data). **Table 12** presents the non-cancer risks for an additional protective clothing/PPE level (e.g., extra layer of clothing, respirator, and chemical-resistant gloves). **Table 13** presents the non-cancer risks for the engineering control exposure level (e.g., closed cab or closed mixing systems).
The cancer risks for the scenario and exposure levels in **Tables 11, 12**, and **13** are presented in **Tables 14, 15**, and **16.**

Tables 10 through 16 also illustrate the procedures used to calculate the MOE values and cancer risks for each level of mitigation. Included in each table are the absorbed daily dose for dermal and inhalation; total absorbed daily dose levels, and lifetime average daily dose used in the MOE and cancer risk calculations.

Table 17 summarizes the caveats and parameters specific to the data used for each exposure/risk assessment scenario. These caveats include the source of the data and an assessment of the overall quality of the data. The assessment of data quality is based on the number of observations and the available quality control data. The quality control data are assessed based on a grading criteria established by the PHED task force. Additionally, it should be noted that all calculations were completed based on current HED policies pertaining to the completion of occupational and residential exposure/risk assessments (e.g., rounding, exposure factors, and acceptable data sources).

(3) pilots applying granulars using aerial equipment

Pilots exposure and risk from applying granulars using aerial equipment was estimating based on a closed cockpit (engineering control), single layer of clothing, and no gloves. The short- and intermediate-term dermal MOEs are 120 and 14, respectively (Table 13). The short- and intermediate-term inhalation MOEs are 750 and 3, respectively. The combined short-term and intermediate-term MOEs are 39 and 2, respectively. The cancer risk is 6.2E-5.

(4) flagging during aerial application of granulars

Flaggers exposure and risk during aerial application of granulars using aerial equipment was estimating for 3 exposure levels: the baseline level of clothing (single layer of clothing, no gloves- Table 11) , additional clothing/PPE (single layer with additional layer of clothing, no gloves - Table 12), and for flaggers sitting a closed cab vehicle (engineering control - Table 13).

For the baseline level of clothing, the short- and intermediate-term dermal MOEs are 76 and 8, respectively. The short- and intermediate-term inhalation MOEs are 6,500 and 24, respectively. The combined short-term and intermediate-term MOEs are 25 and 6, respectively. The cancer risk is 3.9E-5.

For the additional clothing/PPE level, the short- and intermediate-term dermal MOEs are 180 and 20, respectively. The short- and intermediate-term inhalation MOEs are 130,000 and 490, respectively. The combined short-term and intermediate-term MOEs are 60 and 19, respectively. The cancer risk is 1.5E-5.

For the engineering control level, the short- and intermediate-term dermal MOEs are 4,500 and 500 respectively. The short- and intermediate-term inhalation MOEs are 330,000 and 1,200, respectively. The combined short-term and intermediate-term MOEs are 1500 and 360, respectively. The cancer risk is 6.7E-7.

(6) pilots applying liquids using aerial equipment

Pilots exposure and risk from applying liquids using aerial equipment was estimating based on a closed cockpit (engineering control- Tables 13 and 16), single layer of clothing, and no gloves. The short- and intermediate-term dermal MOEs are 70 and 8, respectively. The short- and intermediate-term inhalation MOEs are 24,000 and 89, respectively. The combined short-term and intermediate-term MOEs are 23 and 7, respectively. The cancer risk is 4.5E-5.

(7) flagging during aerial application of liquids

Flaggers exposure and risk during aerial application of liquids using aerial equipment was estimating for 3 exposure levels: the baseline level of clothing (single layer of clothing, no gloves - Table 11) , additional clothing/PPE (single layer with additional layer of clothing, no gloves - Table 12), and for flaggers sitting a closed cab vehicle (engineering control- Tables 13 and 16).

For the baseline level of clothing, the short- and intermediate-term dermal MOEs are 32 and 4, respectively. The short- and intermediate-term inhalation MOEs are 4,600 and 17, respectively. The combined short-term and intermediate-term MOEs are 11 and 3, respectively. The cancer risk is 1.0E-4.

For the additional clothing/PPE level, the short- and intermediate-term dermal MOEs are 34 and 4, respectively. The short- and intermediate-term inhalation MOEs are 90,000 and 340, respectively. The combined short-term and intermediate-term MOEs are 11 and 4, respectively. The cancer risk is 8.9E-5.

For the engineering control level, the short- and intermediate-term dermal MOEs are 1,600 and 180 respectively. The short- and intermediate-term inhalation MOEs are 230,000 and 870, respectively. The combined short-term and intermediate-term MOEs are 530 and 150, respectively. The cancer risk is 2.1E-6.

(8) loading granulars for ground-based applications;

Handlers exposure and risk during the loading of granulars for ground application was estimated for 2 exposure levels: the baseline level of clothing (single layer of clothing, chemical-resistant gloves - Table 11) and for additional clothing/PPE (single layer with additional layer of clothing, chemical-resistant gloves, and a full face respirator - Table 12).

For the baseline level of clothing, the short- and intermediate-term dermal MOEs are 110 and 13, respectively. The short- and intermediate-term inhalation MOEs are 2,200 and 8, respectively. The combined short-term and intermediate-term MOEs are 38 and 5, respectively. The cancer risk is 4.1E-5.

For the additional clothing/PPE level, the short- and intermediate-term dermal MOEs are 230 and 26, respectively. The short- and intermediate-term inhalation MOEs are 43,000 and 160, respectively. The combined short-term and intermediate-term MOEs are 77 and 22, respectively. The cancer risk is 1.3E-5.

(9) applying granulars using ground-based equipment;

Applicator exposure and risk during ground-based application of granulars was estimating for 3 exposure levels: the baseline level of clothing (open cab, single layer of clothing, and chemical-resistant gloves - Table 11), additional clothing/PPE (single layer with additional layer of clothing, chemical-resistant gloves, and full face respirator - Table 12), and for engineering controls (closed cabs - Table 13).

For the baseline level of clothing, the short- and intermediate-term dermal MOEs are 110 and 12, respectively. The short- and intermediate-term inhalation MOEs are 3,000 and 11, respectively. The combined short-term and intermediate-term MOEs are 36 and 6, respectively. The cancer risk is 3.8E-5.

For the additional clothing/PPE level, the short- and intermediate-term dermal MOEs are 190 and 21, respectively. The short- and intermediate-term inhalation MOEs are 61,000 and 230, respectively. The combined short-term and intermediate-term MOEs are 63 and 19, respectively. The cancer risk is 1.6E-5.

For the engineering control level, the short- and intermediate-term dermal MOEs are 390 and 44 respectively. The short- and intermediate-term inhalation MOEs are 17,000 and 62, respectively. The combined short-term and intermediate-term MOEs are 130 and 62, respectively. The cancer risk is 9.4E-6.

(10) mixing/loading liquids for ground-based applications;

Handler exposure and risk during the mixing/loading of liquids for ground-based application was estimated for 3 exposure levels: the baseline level of clothing (open mix system, single layer of clothing, and chemical-resistant gloves - Table 11), additional clothing/PPE (single layer with additional layer of clothing, chemical-resistant gloves, and full face respirator - Table 12), and for engineering controls (closed mixing systems - Table 13).

For the baseline level of clothing, the short- and intermediate-term dermal MOEs are 57 and 6, respectively. The short- and intermediate-term inhalation MOEs are 5,100 and 19, respectively. The combined short-term and intermediate-term MOEs are 19 and 5, respectively. The cancer risk is 7.2E-5.

For the additional clothing/PPE level, the short- and intermediate-term dermal MOEs are 75 and 8, respectively. The short- and intermediate-term inhalation MOEs are 100,000 and 380, respectively. The combined short-term and intermediate-term MOEs are 25 and 8, respectively. The cancer risk is 4.9E-5.

For the engineering control level, the short- and intermediate-term dermal MOEs are 150 and 17 respectively. The short- and intermediate-term inhalation MOEs are 73,000 and 270, respectively. The combined short-term and intermediate-term MOEs are 51 and 16, respectively. The cancer risk is 2.4E-5.

(11) applying liquids using ground-based equipment;

Applicator exposure and risk during ground-based application of liquids was estimated for 3 exposure levels: the baseline level of clothing (open cab, single layer of clothing, and gloves), additional clothing/PPE (single layer with additional layer of clothing, gloves, and full face respirator), and for engineering controls (closed cabs).

For the baseline level of clothing, the short- and intermediate-term dermal MOEs are 94 and 10, respectively. The short- and intermediate-term inhalation MOEs are 8,200 and 31 respectively. The combined short-term and intermediate-term MOEs are 31 and 8, respectively. The cancer risk is 4.4E-5.

For the additional clothing/PPE level, the short- and intermediate-term dermal MOEs are 120 and 13, respectively. The short- and intermediate-term inhalation MOEs are 160,000 and 620, respectively. The combined short-term and intermediate-term MOEs are 40 and 13, respectively. The cancer risk is 3.1E-5.

For the engineering control level, the short- and intermediate-term dermal MOEs are 260 and 29 respectively. The short- and intermediate-term inhalation MOEs are 14,000 and 53, respectively. The combined short-term and intermediate-term MOEs are 86 and 19, respectively. The cancer risk is 1.7E-5.

3.3 Occupational Risk Assessment/Characterization

3.3.1. General Risk Characterization Considerations

Several issues must be considered that pertain to the quality of the assessment and when interpreting the results of the occupational handler risk assessment. These include:

- Several handler assessments were completed using "low quality" PHED data due to the lack of a more acceptable data set (see Exposure Scenario Table for further details).

- Several generic protection factors were used to calculate handler exposures. The protection factors used for clothing layers and gloves have not been completely evaluated by HED. The key element being evaluated by HED is the factor for clothing. The value used for respiratory protection is based on the *NIOSH Respirator Decision Logic* and the value for gloves is in the range that OSHA and NIOSH often use.

- The PHED surrogate exposure values can be described as values that are generally between the geometric mean and the median of the data set used for calculation of the value.

Refinement of the ORE exposure and risk assessment calculations presented in this chapter is possible if the issues presented above are addressed by the registrant or if more refined approaches and data become available to HED.

3.3.2. Summary of Total Risks to Occupational Handlers

(i) Risk estimated using biomonitoring data

Short-term, intermediate-term and cancer risks for the three aerial mixing/loading scenarios [(1)loading granulars for aerial applications; (2) truck drivers supporting loading granulars for aerial applications; (5) mixing/ loading liquids for aerial applications] were evaluated using biomonitoring exposure data from MRID# **442122-01** and EPA MRID# **431656-02** . Since biomonitoring data was used for the unit exposures the risk reflects dermal and inhalation exposure routes. Results from each assessment are presented below (i.e., short-term assessment followed by intermediate-term and cancer assessments).

Since biomonitoring data was used to estimate exposure and risk for these three scenarios, it was not possible to calculate the effects of further mitigation methods. The risks calculated using biomonitoring data reflect exposure that handlers in the study received from multiple routes (dermal, inhalation, and oral).

<u>Short-Term Risks</u> (using biomonitoring data, risk concern: MOEs < 300)

The calculations of short-term total risks indicate that the MOEs are less than <u>300</u> for the both aerial mixing/loading scenarios:

(1) loading granulars for aerial applications (assessment was based on high-end assumption of 1,680 lbs ai handled/day; mean adult body weight of 70 kg; handlers wearing single layer clothing, Tyvek or carbon impregnated suits, full face respirator, and gloves; direct or direct/trans loading 1280-lb bags)

(5) mixing/loading liquids for aerial applications (assessment was based on high-end assumption of 900 lbs ai handled/day; mean adult body weight of 70 kg; handlers wearing single layer clothing, Kleengard or activated carbon suits, half-face respirator, and gloves;)

[Note: Short-term MOEs for actual handlers in the granular study (that the unit exposures were derived) were greater than 300 for direct loaders wearing carbon suits and for drivers (wearing no suits and carbon suits)]

<u>Intermediate-Term Risks</u> (using biomonitoring data, risk concern: MOEs < 100)

The calculations of intermediate-term total risks indicate that the MOEs are equal to, or greater than <u>100</u> for only one scenario: (2) truck drivers supporting loading granulars for aerial applications; The intermediate-term MOEs for the other scenarios range from 17 to 73.

<u>Cancer Risks</u> (using biomonitoring data, risk concern: cancer risk > 1.0E-4)

The calculations of cancer risks indicate that the risk is less than 1.0E-4 for all scenarios assessed with biomonitoring data (range 2.2 E-5 to 1.1E-6).

(ii) Risk estimated using unit exposures from PHED

<u>Short-Term Dermal Risks</u> (using PHED data, risk concern: MOEs < 300)

For the baseline clothing and additional clothing/PPE levels, all of short-term dermal MOEs were less than <u>300</u> (MOEs ranged from 32 to 230). Engineering controls resulted in short-term dermal MOEs above <u>300</u> for the following scenarios:

(4) flagging during aerial application of granulars (assessment based on the use of a closed cab truck; single layer of clothing without gloves; maximum application rate; high-end acres treated/day; low confidence unit exposure values, 40% dermal absorption)

(7) flagging during aerial application of liquids (assessment based on the use of a closed cab truck; single layer of clothing without gloves; maximum application rate; high-end acres treated/day; low confidence unit exposure values, 40% dermal absorption)

(9) applying granulars using ground-based equipment (assessment based on the use of a enclosed groundboom cab; single layer of clothing with gloves; maximum application rate; high-end acres treated/day; high confidence unit exposure values, 40% dermal absorption)

<u>Short-Term Inhalation Risks</u> (using PHED data, risk concern: MOEs < 100)

Short-term inhalation MOEs were above 100 at the baseline level for the following scenarios:

(4) flagging during aerial application of granulars;
(6) pilots applying liquids using aerial equipment;
(7) flagging during aerial application of liquids;
(8) loading granulars for ground-based applications;
(9) applying granulars using ground-based equipment;
(10) mixing/loading liquids for ground-based applications;
(11) applying liquids using ground-based equipment

Short-Term Risks (combined dermal and inhalation doses using PHED data, risk concern: MOEs < 100)

All of the short-term combined MOEs were less than 100 at the baseline and additional PPE levels. Short-term combined MOEs were above 100 at the engineering control level for the following scenarios:

(4) flagging during aerial application of granulars;
(7) flagging during aerial application of liquids;
(9) applying granulars using ground-based equipment;

Intermediate-Term Dermal Risks (using PHED data, risk concern: MOEs < 100)

For the baseline clothing and additional clothing/PPE levels, all of intermediate-term dermal MOEs were less than 100 (MOEs ranged from 4 to 26). Engineering controls resulted in short-term dermal MOEs above 100 for the following scenarios:

(4) flagging during aerial application of granulars;
(7) flagging during aerial application of liquids;

Intermediate-Term Inhalation Risks (using PHED data, risk concern: MOEs < 100)

For the baseline clothing level, all of intermediate-term dermal MOEs were less than 100 (MOEs ranged from 8 to 31). The addition of a full face respirator results in MOEs above 100 for the following scenarios :

(3) pilots applying granulars using aerial equipment;
(4) flagging during aerial application of granulars;
(6) pilots applying liquids using aerial equipment;
(7) flagging during aerial application of liquids;
(8) loading granulars for ground-based applications;
(9) applying granulars using ground-based equipment;
(10) mixing/loading liquids for ground-based applications;
(11) applying liquids using ground-based equipment

Intermediate-Term Risks (combined dermal and inhalation doses using PHED data, risk concern: MOEs < 100)

All of the intermediate-term combined MOEs were less than 100 at the baseline and additional PPE levels. Intermediate-term combined MOEs were above 100 at the engineering control level for the following scenarios:

(4) flagging during aerial application of granulars;
(7) flagging during aerial application of liquids;

Cancer Occupational Handler Risks (using PHED data, risk concern: cancer risk > 1.0E-4)

The calculations of cancer risks indicate that the risk is less than 1.0E-4 at the baseline level of clothing for six scenarios (range 1.0E-4 to 7.2E-5). The cancer risk for pilots applying granulars and liquids is 6.2E-5 and 4.5E-5, respectively [see Table 13 for pilots, they are not included in baseline level or additional clothing/PPE level]

3.3.3. Occupational Risks From Postapplication Exposures

Based on use pattern of molinate with rice (i.e. applied pre-plant, early post-emergent/pre-flood stage, and post flood), the exposure and risk from molinate during post-application activities is expected to be minimal. Workers entering flooded fields to perform scouting tasks will be wearing rubber boots. Also, hand-labor activities are not expected for rice. Thus, a quantitative exposure and risk assessment for post-application activities was not performed.

3.3.4. Incident reports

Insert historical incident report section here from previous HED RED chapter.

3.3.5. Data requirements

HED requests a meeting with registrant to discuss further mitigation measures.

Table 8. Exposure and Risk Assessment for Workers Loading Granulars into Airplane Hoppers from Biomonitoring Study

Using actual exposure from biomonitoring study (MRID 43165602)									
Task	PPE	lb ai handled/ 3 days (mean)	mean body wt (kg)	mg/lb ai handled (geometric mean)	Daily Dose[1] mg/kg/day (geometric mean)	LADD[2] mg/kg/day	Short-term MOE[3]	Intermediate-term MOE[4]	Cancer risk[5]
Dir-Lo	Tyvek	2797	95.0	0.000676	0.0062	0.00023	290	33	1.1E-05
	Carbon	1927	94.7	0.000469	0.0028	0.00010	660	73	5.0E-06
Both	Tyvek	2462	90.9	0.000839	0.0065	0.00024	280	31	1.2E-05
	Carbon	3264	85.7	0.000948	0.0116	0.00043	160	17	2.1E-05
Driver	none	-	82.7	-	0.00081	0.00003	2,200	250	1.5E-06
	carbon	-	81.0	-	0.00059	0.00002	3,000	340	1.1E-06

[1] see Tables 1 through 4 of Appendix C

[2] LADD, Lifetime Average Daily Dose (mg/kg/day) = Daily Dose (mg/kg/day) x Days handled per year (27 days/365 days) x [average worker duration/average life expectancy (35 years/70 years)]

[3] Short-term MOE = Oral LOAEL (1.8 mg/kg/day)/ Daily Dose (mg/kg/day)

[4] Intermediate-term MOE = Oral LOAEL (0.2 mg/kg/day)/ Daily Dose (mg/kg/day)

[5] Cancer Risk = Q* (4.92 E-2 mg/kg/day)$^{-1}$ x LADD (mg/kg/day)

Using default body weight of 70 kg and unit exposures normalized to mg/lb ai handled										
Task	PPE	lb ai handled/ day		mg/lb ai handled	Default body wt (kg)	Daily Dose[1] mg/kg/day		LADD[2] mg/kg/day	Short-term MOE[3]	Intermediate-term MOE[4]	Cancer risk[5]
		Max	Avg			w\ Max lb ai/day	w\ Avg lb ai/day				
Dir-Lo	Tyvek	1,680	900	0.000676	70	0.0162	0.0087	0.00032	110	12	1.6E-05
Dir-Lo	Carbon	1,680	900	0.000469	70	0.0113	0.0060	0.00022	160	18	1.1E-05
Both	Tyvek	1,680	900	0.000839	70	0.0201	0.0108	0.00040	90	10	2.0E-05
Both	Carbon	1,680	900	0.000948	70	0.0227	0.0122	0.00045	80	9	2.2E-05

[1] Daily Dose (mg/kg/day) = [Max use rate (lb ai handheld/day) x Unit exposure (mg/lb ai handled)] /Body weight

[2] LADD, Lifetime Average Daily Dose (mg/kg/day) = Daily Dose [using average lb ai handled per day] (mg/kg/day) x Days handled per year (27 days/365 days) x [average worker duration/average life expectancy (35 years/70 years)]

[3] Short-term MOE = Oral LOAEL (1.8 mg/kg/day)/ Daily Dose (mg/kg/day)

[4] Intermediate-term MOE = Oral LOAEL (0.2 mg/kg/day)/ Daily Dose (mg/kg/day)

[5] Cancer Risk = Q* (4.92 E-2 mg/kg/day)$^{-1}$ x LADD (mg/kg/day)

Table 9. Exposure and Risk Assessment for Workers Loading Liquids into Airplane Hoppers from Biomonitoring Study

Using actual exposures from biomonitoring study (MRID 44212201)									
Work Task	PPE	lb ai [1] handled/ 3 days	Body weight [1] (mean)	Unit exposure [1] mg/lb ai handled (geometric mean)	Daily Dose [1] mg/kg/day (geometric mean)	LADD [2] mg/kg/day	Short-term MOE[3]	Intermediate-term MOE[4]	Cancer risk [5]
Loading Arrosolo (liquid)	Level 1: Activated carbon suit worn underneath 'Kleenguard' coveralls	839	83	0.00076	0.0072	0.00024	250	28	1.2E-05
	Level 2: 'Kleenguard' coveralls worn over normal work clothing	857	82	0.00117	0.0111	0.00038	162	18	1.8E-05
	Level 3: Normal work clothing, recommended as long sleeved shirt and long pants	750	82	0.00340	0.0284	0.00097	63	7	4.8E-05

[1] see Tables 1 through 4 of Appendix D
[2] LADD, Lifetime Average Daily Dose (mg/kg/day) = Daily Dose (mg/kg/day) x Days handled per year (25 days/365 days) x [average worker duration/average life expectancy (35 years/70 years)]
[3] Short-term MOE = Oral LOAEL (1.8 mg/kg/day)/ Daily Dose (mg/kg/day)
[4] Intermediate-term MOE = Oral LOAEL (0.2 mg/kg/day)/ Daily Dose (mg/kg/day)
[5] Cancer Risk = Q* (4.92 E-2 mg/kg/day)$^{-1}$ x LADD (mg/kg/day)

Using default body weight of 70 kg, loading rate of 900 lb ai/day, and unit exposures normalized to mg/lb ai handled											
Work Task	PPE	lb ai/ day		body wt (kg)	Unit exposure mg/lb ai handled (geometric mean)	Daily Dose[1] mg/kg/day		LADD [2] mg/kg/day	Short-term MOE[3]	Intermediate-term MOE[4]	Cancer risk [5]
		Max	Avg			w\ Max lb ai/day	w\ Avg lb ai/day				
Loading Arrosolo (liquid)	Level 1: Activated carbon suit worn underneath 'Kleenguard' coveralls	900	300	70	0.00076	0.0098	0.0033	0.00011	184	20	5.4E-06
	Level 2: 'Kleenguard' coveralls worn over normal work clothing	900	300	70	0.00117	0.0150	0.0050	0.00017	120	13	8.4E-06
	Level 3: Normal work clothing, recommended as long sleeved shirt and long pants	900	300	70	0.00340	0.0437	0.0146	0.00050	41	5	2.5E-05

[1] Daily Dose (mg/kg/day) = [Use rate (lb ai handheld/day) x Unit exposure (mg/lb ai handled)] /Body weight
[2] LADD, Lifetime Average Daily Dose (mg/kg/day) = Daily Dose (mg/kg/day) x Days handled per year (25 days/365 days) x [average worker duration/average life expectancy (35 years/70 years)]
[3] Short-term MOE = Oral LOAEL (1.8 mg/kg/day)/ Daily Dose (mg/kg/day)
[4] Intermediate-term MOE = Oral LOAEL (0.2 mg/kg/day)/ Daily Dose (mg/kg/day)
[5] Cancer Risk = Q* (4.92E-2 mg/kg/day)$^{-1}$ x LADD (mg/kg/day)

Table 10. Numerical Inputs from PHED Version 1.1 Used for Molinate Handler Exposure Assessment

No.	Exposure Scenario	Unit Exposures from Pesticide Surrogate Exposure Guide (8/98)						Application Parameters			
		Baseline[a]		Additional PPE[b]		Engineering Controls[c]					
		Dermal (μg/lb ai)	Inhalation (μg/lb ai)	Dermal (μg/lb ai)	Inhalation (μg/lb ai)	Dermal (μg/lb ai)	Inhalation (μg/lb ai)	Application Rate (lb ai/A)[d]		Area Treated (acre/day)[e]	Application Days/year
								Maximum	Typical		
Aerial Applications -Granulars:											
3	pilots applying granulars using aerial equipment	na	na	na	na	1.7	1.3	5	4	300	27
4	flagging during aerial application of granulars	2.75 (single layer, no gloves)	0.15 (single layer, no gloves)	1.17 (additional layer, no gloves)	0.0075 (full-face resp)	0.0462 (enclosed truck cab)	0.003 (enclosed truck cab)	5	4	300	27
Aerial Applications- Liquids:											
6	pilots applying liquids using aerial equipment	na	na	na	na	5.0 (single layer, no gloves, close cab)	0.068 (single layer, no gloves, close cab)	3	3	300	25
7	flagging during aerial application of liquids	11.0 (single layer, no gloves)	0.35 (single layer, no gloves)	10.22 (additional layer, no gloves)	0.018 (full-face resp)	0.22 (single layer, no gloves, enclosed truck cab)	0.007 (single layer, no gloves, enclosed truck cab)	3	3	300	25

No.	Exposure Scenario	Unit Exposures from Pesticide Surrogate Exposure Guide (8/98)						Application Parameters			
		Baseline[a]		Additional PPE[b]		Engineering Controls[c]					
		Dermal (μg/lb ai)	Inhalation (μg/lb ai)	Dermal (μg/lb ai)	Inhalation (μg/lb ai)	Dermal (μg/lb ai)	Inhalation (μg/lb ai)	Application Rate (lb ai/A)[d]		Area Treated (acre/day)[e]	Application Days/year
								Maximum	Typical		
Ground Applications -Granulars:											
8	loading granulars for ground-based applications	6.9 (single layer, gloves, open mixing)	1.7 (single layer, gloves, open mixing)	3.4 (additional layer, gloves)	0.085 (full-face resp)	NF	NF	5	4	80	30
9	applying granulars using ground-based equipment	7.2 (single layer, gloves, open cab)	1.2 (single layer, gloves, open cab)	4.18 (additional layer, gloves)	0.06 (full-face resp)	2.0 (single layer, gloves, enclosed truck cab)	0.220 (single layer, gloves, enclosed truck cab)	5	4	80	30
Ground Applications- Liquids:											
10	mixing/loading liquids for ground-based applications	23 (single layer, gloves, open mixing)	1.2 (single layer, gloves, open mixing)	17.5 (additional layer, gloves)	0.06 (full-face resp)	8.6 (single layer, gloves, closed mixing system)	0.083 (single layer, gloves, closed mixing system)	3	3	80	30
11	applying liquids using ground-based equipment	14 (single layer, gloves, open cab)	0.74 (single layer, gloves, open cab)	11.0 (additional layer, gloves)	0.037 (full-face resp)	5.1 (single layer, gloves, closed cab)	0.43 (single layer, gloves, closed cab)	3	3	80	30

"No Data" or '"na" indicates that no appropriate data are available for incorporation into this cell. "N/F" indicates that this exposure scenario is not considered feasible by HED due to engineering or other practical considerations (e.g., an open cockpit aerial application scenario is not considered feasible as aircraft appropriate for this use are not manufactured with open cockpits).

a Baseline clothing and PPE scenario: Workers wearing single layer clothing, chemical resistant gloves, and no respirator. Also open cab for applicators and flaggers. Exceptions are noted on an individual basis.

b PPE: Workers typically wear double layer of clothing, chemical resistant gloves, and respirator. Exceptions are noted on an individual basis.

c Engineering controls: Workers wearing single layer clothing and no gloves while using an appropriate engineering control system (e.g., closed mixing, enclosed cabs).

d See **Section 3.2.3.** for derivation of application rates.

e HED believes these values represent a reasonable estimation of the median to upper percentile of what can be treated in a single day based on the exposure scenario of concern. Users of this table are cautioned to note that these values are based on professional judgement when appropriate data are not available.

Table 11. Non-Cancer Risks For Occupational Molinate Handlers at **Baseline Clothing Scenario** (Unit Exposures from PHED)

No.	Exposure Scenario	Absorbed Daily Dose using Max Application Rate (mg/kg/day)		Short-Term Risk (MOE)			Intermediate-Term Risk (MOE)		
		Dermal [a]	Inhalation [b]	Dermal [c]	Inhalation [d]	Combined [e]	Dermal [f]	Inhalation [g]	Combined [h]
Aerial Applications -Granulars:									
3	pilots applying granulars using aerial equipment								
4	flagging during aerial application of granulars	0.0236	0.0032	76	6500	25	8	24	6
Aerial Applications- Liquids:									
6	pilots applying liquids using aerial equipment								
7	flagging during aerial application of liquids	0.0566	0.0045	32	4600	11	4	17	3
Ground Applications -Granulars:									
8	loading granulars for ground-based applications	0.0158	0.0097	110	2200	38	13	8	5
9	applying granulars using ground-based equipment	0.0165	0.0069	110	3000	36	12	11	6
Ground Applications- Liquids:									
10	mixing/loading liquids for ground-based applications	0.0315	0.0041	57	5100	19	6	19	5
11	applying liquids using ground-based equipment	0.0192	0.0025	94	8200	31	10	31	8

"No Data" indicates that no appropriate data are available for incorporation into this cell. "N/F" indicates that this exposure scenario is not considered feasible by HED due to engineering or other practical considerations (e.g., an open cockpit aerial application scenario is not considered feasible as aircraft appropriate for this use are not manufactured with open cockpits). N/A indicates that an appropriate risk level has been obtained and there is no need for imposition of a more protective level of risk mitigation.

[a] Absorbed daily dermal dose (mg/kg/day) = $\frac{\text{unit exposure } (\mu g/\text{lb ai})*(1E\text{-}3 \text{ mg/ug}) \text{ unit conversion} * \text{application rate (lb ai/A)} * \text{acres treated (acres/day)} * \text{dermal absorption (40\%)}}{\text{body weight (70 kg)}}$

[b] Absorbed daily inhalation dose (mg/kg/day) = $\frac{\text{unit exposure } (\mu g/\text{lb ai}) *1E\text{-}3 \text{ mg/ug} * \text{application rate (lb ai/A)} * \text{acres treated (acres/day)} * \text{inhalation absorption (100\%)}}{\text{body weight (70 kg)}}$

[c] Short-Term Dermal MOE = [LOAEL (1.8 mg/kg/day)] /absorbed daily dose (mg/kg/day). MOEs < 300 indicate a risk concern

[d] Short-Term Inhalation MOE = NOAEL (20.9 mg/kg/day)/absorbed daily dose (mg/kg/day). MOEs < 100 indicate a risk concern

[e] Short-Term Dermal MOE = [LOAEL (1.8 mg/kg/day) x 1/3] /absorbed daily dose (mg/kg/day).
Combined MOE = 1 ÷ (1/ Dermal MOE) + (1/Inhalation MOE)

[f] Intermediate-Term Dermal MOE = NOAEL (0.2 mg/kg/day)/absorbed daily dose (mg/kg/day). MOEs < 100 indicate a risk concern.

[g] Intermediate-Term Inhalation MOE = NOAEL (0.078 mg/kg/day)/absorbed daily dose (mg/kg/day). MOEs < 100 indicate a risk concern.

h Combined MOE = 1 ÷ (1/ Dermal MOE) + (1/Inhalation MOE)

Table 12. Non-Cancer Risks For Occupational Molinate Handlers at **Additional Protective Clothing and PPE to Mitigate Exposures** (Unit Exposures from PHED)

No.	Exposure Scenario	Absorbed Daily Dose using Max Application Rate (mg/kg/day)		Short-Term Risk (MOE)			Intermediate-Term Risk (MOE)		
		Dermal [a]	Inhalation [b]	Dermal [c]	Inhalation [d]	Combined [e]	Dermal [f]	Inhalation [g]	Combined [h]
Aerial Applications -Granulars:									
3	pilots applying granulars using aerial equipment								
4	flagging during aerial application of granulars	0.010	0.00016	180	130,000	60	20	490	19
Aerial Applications- Liquids:									
6	pilots applying liquids using aerial equipment								
7	flagging during aerial application of liquids	0.0526	0.00023	34	90,000	11	4	340	4
Ground Applications -Granulars:									
8	loading granulars for ground-based applications	0.0078	0.00049	230	43,000	77	26	160	22
9	applying granulars using ground-based equipment	0.0096	0.00034	190	61,000	63	21	230	19
Ground Applications- Liquids:									
10	mixing/loading liquids for ground-based applications	0.0240	0.00021	75	100,000	25	8	380	8
11	applying liquids using ground-based equipment	0.0151	0.00013	120	160,000	40	13	620	13

"No Data" indicates that no appropriate data are available for incorporation into this cell. "N/F" indicates that this exposure scenario is not considered feasible by HED due to engineering or other practical considerations (e.g., an open cockpit aerial application scenario is not considered feasible as aircraft appropriate for this use are not manufactured with open cockpits). N/A indicates that an appropriate risk level has been obtained and there is no need for imposition of a more protective level of risk mitigation.

[a] Absorbed daily dermal dose (mg/kg/day) = $\frac{\text{unit exposure } (\mu\text{g/lb ai}) * (\text{1E-3 mg/ug}) \text{ unit conversion} * \text{application rate (lb ai/A)} * \text{acres treated (acres/day)} * \text{dermal absorption (40\%)}}{\text{body weight (70 kg)}}$

[b] Absorbed daily inhalation dose (mg/kg/day) = $\frac{\text{unit exposure } (\mu\text{g/lb ai}) * \text{1E-3 mg/ug} * \text{application rate (lb ai/A)} * \text{acres treated (acres/day)} * \text{inhalation absorption (100\%)}}{\text{body weight (70 kg)}}$

[c]. Short-Term Dermal MOE = [LOAEL (1.8 mg/kg/day)] /absorbed daily dose (mg/kg/day) MOEs < 100 indicate a risk concern

[d] Short-Term Inhalation MOE = NOAEL (20.9 mg/kg/day)/absorbed daily dose (mg/kg/day). MOEs < 100 indicate a risk concern

[e] Short-Term Dermal MOE = [LOAEL (1.8 mg/kg/day) x 1/3] /absorbed daily dose (mg/kg/day)
Combined MOE = 1 ÷ (1/ Dermal MOE) + (1/Inhalation MOE)

[f] Intermediate-Term Dermal MOE = NOAEL (0.2 mg/kg/day)/absorbed daily dose (mg/kg/day). MOEs < 100 indicate a risk concern.
[g] Intermediate-Term Inhalation MOE = NOAEL (0.078 mg/kg/day)/absorbed daily dose (mg/kg/day). MOEs < 100 indicate a risk concern.
h Combined MOE = 1 ÷ (1/ Dermal MOE) + (1/Inhalation MOE)

Table 13. Non-Cancer Risks For Occupational Molinate Handlers at **Engineering Controls to Mitigate Exposures** (Unit Exposures from PHED)

No.	Exposure Scenario	Absorbed Daily Dose using Max Application Rate (mg/kg/day)		Short-Term Risk (MOE)			Intermediate-Term Risk (MOE)		
		Dermal [a]	Inhalation [b]	Dermal [c]	Inhalation [d]	Combined [e]	Dermal [f]	Inhalation [g]	Combined [h]
Aerial Applications -Granulars:									
3	pilots applying granulars using aerial equipment	0.0146	0.0279	120	750	39	14	3	2
4	flagging during aerial application of granulars	0.00040	0.000064	4500	330,000	1,500	500	1,200	360
Aerial Applications- Liquids:									
6	pilots applying liquids using aerial equipment	0.0257	0.00087	70	24,000	23	8	89	7
7	flagging during aerial application of liquids	0.0011	0.000090	1600	230,000	530	180	870	150
Ground Applications -Granulars:									
8	loading granulars for ground-based applications	N/F							
9	applying granulars using ground-based equipment	0.0046	0.0013	390	17,000	130	44	62	26
Ground Applications- Liquids:									
10	mixing/loading liquids for ground-based applications	0.0118	0.00028	150	73,000	51	17	270	16
11	applying liquids using ground-based equipment	0.0070	0.0015	260	14,000	86	29	53	19

"No Data" indicates that no appropriate data are available for incorporation into this cell. "N/F" indicates that this exposure scenario is not considered feasible by HED due to engineering or other practical considerations (e.g., an open cockpit aerial application scenario is not considered feasible as aircraft appropriate for this use are not manufactured with open cockpits). N/A indicates that an appropriate risk level has been obtained and there is no need for imposition of a more protective level of risk mitigation.

[a] Absorbed daily dermal dose (mg/kg/day) = $\frac{\text{unit exposure } (\mu\text{g/lb ai})\text{*(1E-3 mg/ug) unit conversion * application rate (lb ai/A) * acres treated (acres/day) * dermal absorption (40\%)}}{\text{body weight (70 kg)}}$

[b] Absorbed daily inhalation dose (mg/kg/day) = $\frac{\text{unit exposure } (\mu\text{g/lb ai})\text{ *1E-3 mg/ug * application rate (lb ai/A) * acres treated (acres/day) * inhalation absorption (100\%)}}{\text{body weight (70 kg)}}$

[c] Short-Term Dermal MOE = [LOAEL (1.8 mg/kg/day)] /absorbed daily dose (mg/kg/day). MOEs < 100 indicate a risk concern

[d] Short-Term Inhalation MOE = NOAEL (20.9 mg/kg/day)/absorbed daily dose (mg/kg/day). MOEs < 100 indicate a risk concern

[e] Short-Term Dermal MOE = [LOAEL (1.8 mg/kg/day) x 1/3] /absorbed daily dose (mg/kg/day).
Combined MOE = 1 ÷ (1/ Dermal MOE) + (1/Inhalation MOE)

[f] Intermediate-Term Dermal MOE = NOAEL (0.2 mg/kg/day)/absorbed daily dose (mg/kg/day). MOEs < 100 indicate a risk concern.

[g] Intermediate-Term Inhalation MOE = NOAEL (0.078 mg/kg/day)/absorbed daily dose (mg/kg/day). MOEs < 100 indicate a risk concern.

h Combined MOE = 1 ÷ (1/ Dermal MOE) + (1/Inhalation MOE)

Table 14. Cancer Risks For Occupational Molinate Handlers at **Baseline Clothing Scenario** (Unit Exposures from PHED)

No.	Exposure Scenario	Absorbed Daily Dose using Typical Application Rate (mg/kg/day)		Total Absorbed Daily Dose [c] using Typical Application Rate (mg/kg/day)	Lifetime Average Daily Dose [d] (mg/kg/day)	Cancer Risk [e]
		Dermal [a]	Inhalation [b]			
Aerial Applications -Granulars:						
3	pilots applying granulars using aerial equipment					
4	flagging during aerial application of granulars	0.0189	0.0026	0.0214	7.9E-4	3.9E-5
Aerial Applications- Liquids:						
6	pilots applying liquids using aerial equipment					
7	flagging during aerial application of liquids	0.0566	0.0045	0.0611	2.1E-3	1.0E-4
Ground Applications -Granulars:						
8	loading granulars for ground-based applications	0.0126	0.0078	0.0204	8.4E-4	4.1E-5
9	applying granulars using ground-based equipment	0.0132	0.0055	0.0187	7.7E-4	3.8E-5
Ground Applications- Liquids:						
10	mixing/loading liquids for ground-based applications	0.0315	0.0041	0.0357	1.5E-3	7.2E-5
11	applying liquids using ground-based equipment	0.0192	0.0025	0.0217	8.9E-4	4.4E-5

"No Data" indicates that no appropriate data are available for incorporation into this cell. "N/F" indicates that this exposure scenario is not considered feasible by HED due to engineering or other practical considerations (e.g., an open cockpit aerial application scenario is not considered feasible as aircraft appropriate for this use are not manufactured with open cockpits). N/A indicates that an appropriate risk level has been obtained and there is no need for imposition of a more protective level of risk mitigation.

[a] Absorbed daily dermal dose (mg/kg/day) = $\frac{\text{unit exposure } (\mu\text{g/lb ai})*(1\text{E-3 mg/ug}) \text{ unit conversion * application rate (lb ai/A) * acres treated (acres/day) * dermal absorption (40\%)}}{\text{body weight (70 kg)}}$

[b] Absorbed daily inhalation dose (mg/kg/day) = $\frac{\text{unit exposure } (\mu\text{g/lb ai}) \text{ *1E-3 mg/ug * application rate (lb ai/A) * acres treated (acres/day) * inhalation absorption (100\%)}}{\text{body weight (70 kg)}}$

[c] Total Daily Absorbed Dose (mg/kg/day) = absorbed daily dermal dose (mg/kg/day) + absorbed daily inhalation dose (mg/kg/day)

[d] Lifetime Average Daily Dose (mg/kg/day) = total daily absorbed dose (mg/kg/day) x applications days/365 days x 35 work years/70 year life expectancy

[e] Cancer Risk = Q* [4.92E-2 $(\text{mg/kg/day})^{-1}$] x Lifetime Average Daily Dose. Cancer Risks > 1 x 10^{-4} indicate a risk concern.

Table 15. Cancer Risks For Occupational Molinate Handlers Using **Additional Protective Clothing and PPE to Mitigate Exposures** (Unit Exposures from PHED)

No.	Exposure Scenario	Absorbed Daily Dose using Typical Application Rate (mg/kg/day)		Total Absorbed Daily Dose [c] using Typical Application Rate (mg/kg/day)	Lifetime Average Daily Dose [d] (mg/kg/day)	Cancer Risk [e]
		Dermal [a]	Inhalation [b]			
Aerial Applications -Granulars:						
3	pilots applying granulars using aerial equipment					
4	flagging during aerial application of granulars	0.0080	0.00013	0.082	3.0E-4	1.5E-5
Aerial Applications- Liquids:						
6	pilots applying liquids using aerial equipment					
7	flagging during aerial application of liquids	0.0526	0.00023	0.0528	1.8E-3	8.9E-5
Ground Applications -Granulars:						
8	loading granulars for ground-based applications	0.0062	0.00039	0.0066	2.7E-4	1.3E-5
9	applying granulars using ground-based equipment	0.0076	0.00027	0.0079	3.39E-4	1.6E-5
Ground Applications- Liquids:						
10	mixing/loading liquids for ground-based applications	0.0240	0.00021	0.0242	9.9E-4	4.9E-5
11	applying liquids using ground-based equipment	0.0151	0.00013	0.0152	6.3E-4	3.1E-5

"No Data" indicates that no appropriate data are available for incorporation into this cell. "N/F" indicates that this exposure scenario is not considered feasible by HED due to engineering or other practical considerations (e.g., an open cockpit aerial application scenario is not considered feasible as aircraft appropriate for this use are not manufactured with open cockpits). N/A indicates that an appropriate risk level has been obtained and there is no need for imposition of a more protective level of risk mitigation.

[a] Absorbed daily dermal dose (mg/kg/day) = unit exposure (μg/lb ai)*(1E-3 mg/ug) unit conversion * application rate (lb ai/A) * acres treated (acres/day) * dermal absorption (40%) / body weight (70 kg)

[b] Absorbed daily inhalation dose (mg/kg/day) = unit exposure (μg/lb ai) *1E-3 mg/ug * application rate (lb ai/A) * acres treated (acres/day) * inhalation absorption (100%) / body weight (70 kg)

[c] Total Daily Absorbed Dose (mg/kg/day) = absorbed daily dermal dose (mg/kg/day) + absorbed daily inhalation dose (mg/kg/day)

[d] Lifetime Average Daily Dose (mg/kg/day) = total daily absorbed dose (mg/kg/day) x applications days/365 days x 35 work years/70 year life expectancy

[e] Cancer Risk = Q* [4.92E-2 $(mg/kg/day)^{-1}$] x Lifetime Average Daily Dose. Cancer Risks > 1 x 10^{-4} indicate a risk concern.

Table 16. Cancer Risks For Occupational Molinate Handlers Using **Engineering Controls to Mitigate Exposures** (Unit Exposures from PHED)

No.	Exposure Scenario	Absorbed Daily Dose using Typical Application Rate (mg/kg/day)		Total Absorbed Daily Dose [c] using Typical Application Rate (mg/kg/day)	Lifetime Average Daily Dose [d] (mg/kg/day)	Cancer Risk [e]
		Dermal [a]	Inhalation [b]			
Aerial Applications -Granulars:						
3	pilots applying granulars using aerial equipment	0.0117	0.0223	0.0339	1.3E-3	6.2E-5
4	flagging during aerial application of granulars	0.00032	0.00051	0.00037	1.4E-5	6.7E-7
Aerial Applications- Liquids:						
6	pilots applying liquids using aerial equipment	0.0257	0.00087	0.0266	9.1E-4	4.5E-5
7	flagging during aerial application of liquids	0.0011	0.000090	0.0012	4.2E-5	2.1E-6
Ground Applications -Granulars:						
8	loading granulars for ground-based applications					
9	applying granulars using ground-based equipment	0.0037	0.0010	0.0047	1.9E-4	9.4E-6
Ground Applications- Liquids:						
10	mixing/loading liquids for ground-based applications	0.0118	0.00028	0.0121	5.0E-4	2.4E-5
11	applying liquids using ground-based equipment	0.0070	0.0015	0.0085	3.5E-4	1.7E-5

"No Data" indicates that no appropriate data are available for incorporation into this cell. "N/F" indicates that this exposure scenario is not considered feasible by HED due to engineering or other practical considerations (e.g., an open cockpit aerial application scenario is not considered feasible as aircraft appropriate for this use are not manufactured with open cockpits). N/A indicates that an appropriate risk level has been obtained and there is no need for imposition of a more protective level of risk mitigation.

[a] Absorbed daily dermal dose (mg/kg/day) = unit exposure (μg/lb ai)*(1E-3 mg/ug) unit conversion * application rate (lb ai/A) * acres treated (acres/day) * dermal absorption (40%) / body weight (70 kg)

[b] Absorbed daily inhalation dose (mg/kg/day) = unit exposure (μg/lb ai) *1E-3 mg/ug * application rate (lb ai/A) * acres treated (acres/day) * inhalation absorption (100%) / body weight (70 kg)

[c] Total Daily Absorbed Dose (mg/kg/day) = absorbed daily dermal dose (mg/kg/day) + absorbed daily inhalation dose (mg/kg/day)

[d] Lifetime Average Daily Dose (mg/kg/day) = total daily absorbed dose (mg/kg/day) x applications days/365 days x 35 work years/70 year life expectancy

[e] Cancer Risk = Q* [4.92E-2 $(mg/kg/day)^{-1}$] x Lifetime Average Daily Dose. Cancer Risks > 1 x 10^{-4} indicate a risk concern.

Table 17. Exposure Scenario Descriptions For Occupational Molinate Handlers Evaluated with PHED							
No.	Exposure Scenarios	Data Source	Clothing/PPE/Equipment Use Descriptions			Standard Assumptions (8-hr work day)[a]	Comments[b,c]
			Baseline	PPE	Engineering Controls		
Aerial Applications -Granulars:							
3	pilots applying granulars using aerial equipment	PHED V1.1 Aug 1998	Not considered feasible by Agency	Not considered feasible by Agency	Closed cockpit, single layer clothing, no gloves, no respirator	300 acres per day	**Baseline:** Not feasible. **PPE:** Not feasible. **Engineering Control:** Dermal = C grade; hand and inhalation = all grade. Dermal = 9 to 13 replicates; hand = 4 replicates; and inhalation = 13 replicates. Low confidence in all data. A 50% protection factor was used to account for a layer of clothing as the only data available were for a total deposition scenario.
4	flagging during aerial application of granulars	PHED V1.1 Aug 1998	single layer, no gloves, no respirator Standing in or on perimeter of treatment area.	double layer, no gloves, no respirator Standing in or on perimeter of treatment area.	Closed cab vehicle, single layer clothing, no gloves, no respirator	300 acres per day	**The dermal values for baseline, PPE, and engineering scenarios were extrapolated from total deposition data and are considered 'rough estimates'.** **Total Deposition:** Dermal = ABC grade, hand = all grade, and inhalation = E grade. Dermal = 16 to 20 replicates; hand = 4 replicates; and inhalation = 4 replicates. Low confidence in all data. **Baseline & PPE:** A 50% protection factor was used to account for a layer of clothing as the only data available were for a total deposition scenario. A 95% protection factor was used to account for the use of a full face respirator. **Engineering Control**: A 98% protection factors was used to account for ta closed cab vehicle
Aerial Applications- Liquids:							
6	pilots applying liquids using aerial equipment	PHED V1.1 Aug 1998	Not considered feasible by Agency	Not considered feasible by Agency	Closed cockpit, single layer clothing, no gloves, no respirator	300 acres per day	**Baseline:** Not feasible. **PPE:** Not feasible. **Engineering Control:** Dermal and inhalation = ABC grade; and hand = acceptable grade. Dermal = 24 to 48 replicates; hand = 34 replicates; and inhalation = 23 replicates. Medium confidence in dermal/hand and inhalation data. No protection factors were required to define any unit exposure value.

Table 17. Exposure Scenario Descriptions For Occupational Molinate Handlers Evaluated with PHED							
No.	Exposure Scenarios	Data Source	Clothing/PPE/Equipment Use Descriptions			Standard Assumptions (8-hr work day)[a]	Comments[b,c]
			Baseline	PPE	Engineering Controls		
7	flagging during aerial application of liquids	PHED V1.1 Aug 1998	single layer, no gloves, no respirator. Standing in or on perimeter of treatment area.	double layer, no gloves, full-face respirator Standing in or on perimeter of treatment area..	Closed cab truck, single layer clothing, no gloves, no respirator	300 acres per day	**Baseline:** Dermal, hand, and inhalation data are acceptable grade. Dermal = 18 to 28 replicates; hand = 30 replicates; and inhalation = 28 replicates. High confidence in all data. No protection factors were required to define any unit exposure value. **PPE:** The same dermal and inhalation data are used as for the baseline coupled with a 50% protection factor to account for an additional layer of clothing and a 95% protection factor to account for the use of a full-face respirator. A protection factor was not required for the hand assessment. Hands = acceptable grades. Hands =6 replicates. Low confidence in hand data. **Engineering Controls:** The same dermal, inhalation, and hand data are used as for the baseline coupled with a 98% protection factor to account for the use of an engineering control (i.e., sitting in a vehicle).
Ground Applications -Granulars:							
8	loading granulars for ground-based applications	PHED V1.1 Aug 1998	single layer, gloves, no respirator, open loading	double layer, gloves, full-face respirator	N/F	80 acres per day	**Baseline:** Inhalation data are acceptable grade. Hand data are all grade. Dermal data are ABC grade. Hand = 10 replicates; dermal = 33 to 78 replicates; and inhalation = 58 replicates. High confidence in inhalation data. Low confidence in dermal/hand data. No protection factors were needed to define any unit exposure value. **PPE:** The same inhalation data are used as for the baseline coupled with a 95% protection factor to account for the use of a full-face respirator. A protection factor was not required for the hand or dermal assessments. Hands = acceptable grade and dermal = ABC grade. Hands = 45 replicates and dermal = 12 to 59 replicates. Low confidence in hand/dermal data. **Engineering Controls:** The same dermal, inhalation, and hand data are used as for the baseline coupled with a 90% protection factor to account for the use of an engineering control (i.e., sitting in a vehicle).

Table 17. Exposure Scenario Descriptions For Occupational Molinate Handlers Evaluated with PHED							
No.	Exposure Scenarios	Data Source	Clothing/PPE/Equipment Use Descriptions			Standard Assumptions (8-hr work day)[a]	Comments[b,c]
			Baseline	PPE	Engineering Controls		
9	applying granulars using ground-based equipment	PHED V1.1 Aug 1998	single layer, gloves, no respirator, open cab	double layer, gloves, full-face respirator	Closed cab, single layer, gloves, no respirator	80 acres per day	**Baseline:** Inhalation data are low confidence, 5 replicates, AB grade. Hand /Dermal data is Low confidence, hand replicates = 5, AB grade. A 90% protection factor was used to account for gloves. Dermal replicates = 1 to 5, AB grade **PPE**: The same inhalation data are used as for the baseline coupled with a 95% protection factor to account for the use of a respirator. The same dermal data are used as for the baseline coupled with an additional 50% protection factor to account for a second layer of clothing. **Engineering Controls:** Inhalation data are High confidence, 37 replicates, AB grade. Dermal and Hand data are High Confidence. Dermal replicates 2 to 30, AB grade. Hand replicates = 17, AB grade
Ground Applications- Liquids:							
10	mixing/loading liquids for ground-based applications	PHED V1.1 Aug 1998	single layer, gloves, no respirator, open loading	double layer, gloves, full-face respirator	closed mixing system, single layer, gloves, no respirator	80 acres per day	**Baseline:** Inhalation data is high Confidence, 85 replicates, AB Grade. Dermal and Hand data are High Confidence. Dermal replicates 72 to 122, AB grade. Hand replicates = 53, AB grade **PPE**: The same inhalation data are used as for the baseline coupled with a 95% protection factor to account for the use of a respirator. The same dermal data are used as for the baseline coupled with an additional 50% protection factor to account for a second layer of clothing. **Engineering Controls:** Inhalation data is MediumConfidence, 23 replicates, ABC Grade. Dermal and Hand data are Medium Confidence. Dermal replicates 24 to 48, ABC grade. Hand replicates = 34, AB grade

Table 17. Exposure Scenario Descriptions For Occupational Molinate Handlers Evaluated with PHED							
No.	Exposure Scenarios	Data Source	Clothing/PPE/Equipment Use Descriptions			Standard Assumptions (8-hr work day)[a]	Comments[b,c]
			Baseline	PPE	Engineering Controls		
11	applying liquids using ground-based equipment	PHED V1.1 Aug 1998	single layer, gloves, no respirator, open cab	double layer, gloves, full-face respirator	Closed cab, single layer, gloves, no respirator	80 acres per day	**Baseline:** Inhalation data is high Confidence, 22 replicates, AB Grade. Dermal and Hand data are High Confidence. Dermal replicates 23 to 42, AB grade. Hand replicates = 29, AB grade **PPE**: The same inhalation data are used as for the baseline coupled with a 95% protection factor to account for the use of a respirator. The same dermal data are used as for the baseline coupled with an additional 50% protection factor to account for a second layer of clothing. **Engineering Controls:** Inhalation data is HighConfidence, 16 replicates, AB Grade. Dermal and Hand data are Medium Confidence. Dermal replicates 20 to 31, ABC grade. Hand replicates = 16, AB grade

a All *Standard Assumptions* are based on an 8-hour work day as estimated by HED. BEAD data were not available.

b All handler exposure assessments in this document are based on the "Best Available" data as defined by the PHED SOP for meeting Subdivision U Guidelines (i.e., completing exposure assessments). Best available grades are assigned to data as follows: matrices with A and B grade data (i.e., Acceptable Grade Data) <u>and</u> a minimum of 15 replicates; if not available, then grades A, B and C data and a minimum of 15 replicates; if not available, then all data regardless of the quality (i.e., All Grade Data) and number of replicates. High quality data with a protection factor take precedence over low quality data with no protection factor. Generic data confidence categories are assigned as follows: High = grades A and B and 15 or more replicates per body part; Medium = grades A, B, and C and 15 or more replicates per body part; and Low = grades A, B, C, D and E <u>or</u> any combination of grades with less than 15 replicates.

c **PHED grading criteria do not reflect overall quality of the reliability of the assessment. Sources of the exposure factors should also be considered in the risk management decision**

Appendix A - Molinate PHED Data Summary for Study 0448 (MRID 40255201)

Liquid Applicator Exposure Data Summary for 0448							
Body Part	Study Code	Distribution Type	Clothing/PPE	Exposure Data (ug/lb ai)	N	Baseline Protection Factor	Baseline Exposure (ug/lb ai)
Head (all)	448	Lognormal	None	0.1638	3	1	0.1638
Neck Front	448	Lognormal	None	0.0189	3	1	0.0189
Neck Back	448	Lognormal	None	0.0200	3	1	0.0200
Upper Arms	448	Lognormal	None	0.3666	3	2	0.1833
Chest	448	Other	Single Layer	0.3550	3	1	0.3550
Back	448	Other	Single Layer	0.3550	3	1	0.3550
Forearms	448	Lognormal	None	0.1745	3	2	0.0873
Thighs	448	Lognormal	None	0.6064	3	2	0.3032
Hands	448	Lognormal	None	0.0262	3	1	0.0262
Dermal							1.5127
Inhalation	448	Lognormal	None	0.6085	3	1	0.6085

Granular Applicator Exposure Data Summary for 0448							
Body Part	Study Code	Distribution Type	Clothing/PPE	Exposure Data (ug/lb ai)	N	Baseline Protection Factor	Baseline Exposure (ug/lb ai)
Head (all)	448	Lognormal	None	0.2115	4	1	0.2115
Neck Front	448	Lognormal	None	0.0178	4	1	0.0178
Neck Back	448	Lognormal	None	0.0179	4	1	0.0179
Upper Arms	448	Lognormal	None	0.5040	4	2	0.2520
Chest	448	Other	Single Layer	0.3550	4	1	0.3550
Back	448	Other	Single Layer	0.3550	4	1	0.3550
Forearms	448	Lognormal	None	0.2204	4	2	0.1102
Thighs	448	Lognormal	None	0.7640	4	2	0.3820
Hands	448	Lognormal	None	0.0735	4	1	0.0735
Dermal							1.7749
Inhalation	448	Lognormal	None	0.7918	4	1	0.7918

Baseline exposure for aerial applicators include engineering controls of the enclose cockpit, long sleeves, long pants and no gloves

Appendix A - Molinate PHED Data Summary for Study 0448 (MRID 40255201)

Liquid Mixer/Loader Data Summary for 0448 -- 5 gallon containers									
Body Part	Study Code	Distribution Type	Clothing/PPE	Exposure Data (ug/lb ai)	N	Baseline Protection Factor	Baseline Exposure (ug/lb ai)	PPE Protection Factor	PPE Exposure (ug/lb ai)
Head (all)	448	Lognormal	None	0.6346	8	1	0.6346	1	0.6346
Neck Front	448	Lognormal	None	0.1001	8	1	0.1001	1	0.1001
Neck Back	448	Lognormal	None	0.0358	7	1	0.0358	1	0.0358
Upper Arms	448	Lognormal	None	1.2533	8	2	0.6267	4	0.3133
Chest	448	Lognormal	Single Layer	0.7205	8	1	0.7205	2	0.3603
Back	448	Lognormal	Single Layer	0.6536	8	1	0.6536	2	0.3268
Forearms	448	Lognormal	None	2.0051	8	2	1.0026	4	0.5013
Thighs	448	Lognormal	None	135.8846	8	2	67.9423	4	33.9712
Hands	448	Lognormal	None	2.0659	8	1	2.0659	10	0.2066
Dermal							73.7820		36.4499
Inhalation	448	Lognormal	None	3.5234	8	1	3.5234	1	3.5234

Granular Mixer/Loader Data Summary - 0448/50 lb bags									
Body Part	Study Code	Distribution Type	Clothing/PPE	Exposure Data (ug/lb ai)	N	Baseline Protection Factor	Baseline Exposure (ug/lb ai)	PPE Protection Factor	PPE Exposure (ug/lb ai)
Head (all)	448	Lognormal	None	0.8375	8	1	0.8375	1	0.8375
Neck Front	448	Lognormal	None	0.1367	8	1	0.1367	1	0.1367
Neck Back	448	Lognormal	None	0.0390	8	1	0.0390	1	0.0390
Upper Arms	448	Lognormal	None	1.6600	8	2	0.8300	4	0.4150
Chest	448	Lognormal	Single Layer	1.7000	8	1	1.7000	2	0.8500
Back	448	Lognormal	Single Layer	1.1822	8	1	1.1822	2	0.5911
Forearms	448	Lognormal	None	1.7952	8	2	0.8976	4	0.4488
Thighs	448	Lognormal	None	11.4072	8	2	5.7036	4	2.8518
Hands	448	Lognormal	None	0.5547	7	1	0.5547	10	0.0555
Dermal							11.8813		6.2254
Inhalation	448	Lognormal	None	17.4348	8	1	17.4348	1	17.4348

Appendix A - Molinate PHED Data Summary for Study 0448 (MRID 40255201)

Liquid Flagger Exposure Data Summary for 0448									
Body Part	Study Code	Distribution Type	Clothing/PPE	Exposure Data (ug/lb ai)	N	Baseline Protection Factor	Baseline Exposure (ug/lb ai)	PPE Protection Factor	PPE Exposure (ug/lb ai)
Head (all)	448	Lognormal	None	32.2210	4	1	32.2210	1	32.2210
Neck Front	448	Lognormal	None	0.3337	4	1	0.3337	1	0.3337
Neck Back	448	Lognormal	None	2.9269	4	1	2.9269	1	2.9269
Upper Arms	448	Lognormal	None	64.5883	4	2	32.2942	4	16.1471
Chest	448	Lognormal	Single Layer	1.5038	3	1	1.5038	2	0.7519
Back	448	Lognormal	Single Layer	10.3020	3	1	10.3020	2	5.1510
Forearms	448	Lognormal	None	4.7871	4	2	2.3936	4	1.1968
Thighs	448	Lognormal	None	9.4084	4	2	4.7042	4	2.3521
Hands	448	Lognormal	None	0.2074	4	1	0.2074	10	0.0207
Dermal							86.8867		61.1012
Inhalation	448	Lognormal	None	2.0659	4	1	2.0659	1	2.0659

Granular Flagger Data Summary for 0448									
Body Part	Study Code	Distribution Type	Clothing/PPE	Exposure Data (ug/lb ai)	N	Baseline Protection Factor	Baseline Exposure (ug/lb ai)	PPE Protection Factor	PPE Exposure (ug/lb ai)
Head (all)	448	Lognormal	None	0.5446	4	1	0.5446	1	0.5446
Neck Front	448	Other	None	0.0150	4	1	0.0150	1	0.0150
Neck Back	448	Lognormal	None	0.0262	4	1	0.0262	1	0.0262
Upper Arms	448	Lognormal	None	1.8173	4	2	0.9087	4	0.4543
Chest	448	Other	Single Layer	0.3550	4	1	0.3550	2	0.1775
Back	448	Other	Single Layer	0.3550	4	1	0.3550	2	0.1775
Forearms	448	Lognormal	None	0.4840	4	2	0.2420	4	0.1210
Thighs	448	Lognormal	None	0.8455	4	2	0.4228	4	0.2114
Hands	448	Lognormal	None	0.0219	4	1	0.0219	10	0.0022
Dermal							2.8911		1.7297
Inhalation	448	Lognormal	None	0.1479	4	1	0.1479	1	0.1479

Baseline Exposure = long pants, long sleeves, no gloves

PPE Exposure = long pants, long sleeves, coveralls , and gloves

Exposure Factors: 10 = 90% reduction , 4 = 25% reduction, 2 = 50% reduction, etc.

Appendix B - Molinate PHED Data Summary for Study 1003 (MRID 42241501)

Granular Mixer/Loader Data Summary for 1003 - 50 lb bags									
Body Part	Study Code	Distribution Type	Clothing/PPE	Exposure Data (ug/lb ai)	N	Baseline Protection Factor	Baseline Exposure (ug/lb ai)	PPE Protection Factor	PPE Exposure (ug/lb ai)
Head (all)	1003/50 lb	Lognormal	None	2.9710	12	1	2.9710	1	2.9710
Neck Front	1003/50 lb	Lognormal	None	0.3428	12	1	0.3428	1	0.3428
Neck Back	1003/50 lb	Lognormal	None	0.2514	12	1	0.2514	1	0.2514
Upper Arms	1003/50 lb	Lognormal	None	0.4665	12	2	0.2333	4	0.1166
Chest	1003/50 lb	Lognormal	Single Layer	0.5691	12	1	0.5691	2	0.2846
Back	1003/50 lb	Lognormal	Single Layer	0.5691	12	1	0.5691	2	0.2846
Forearms	1003/50 lb	Lognormal	None	0.1940	12	2	0.0970	4	0.0485
Thighs	1003/50 lb	Lognormal	None	9.7520	12	2	4.8760	4	2.4380
Lower Legs	1003/50 lb	Lognormal	None	6.0759	12	2	3.0380	4	1.5190
Hands	1003/50 lb	Lognormal	None	2.2989	12	1	2.2989	10	0.2299
Dermal							15.2465		8.4863
Inhalation	1003/50 lb	Lognormal	None	8.0144	12	1	8.0144	1	8.0144

Granular Mixer/Loader Data Summary for 1003 - 1500 lb bags									
Body Part	Study Code	Distribution Type	Clothing/PPE	Exposure Data (ug/lb ai)	N	Baseline Protection Factor	Baseline Exposure (ug/lb ai)	PPE Protection Factor	PPE Exposure (ug/lb ai)
Head (all)	1003/1500 lb	Lognormal	None	1.9774	10	1	1.9774	1	1.9774
Neck Front	1003/1500 lb	Lognormal	None	0.2282	10	1	0.2282	1	0.2282
Neck Back	1003/1500 lb	Lognormal	None	0.1673	10	1	0.1673	1	0.1673
Upper Arms	1003/1500 lb	Lognormal	None	0.4510	10	2	0.2255	4	0.1128
Chest	1003/1500 lb	Lognormal	Single Layer	0.5502	10	1	0.5502	2	0.2751
Back	1003/1500 lb	Lognormal	Single Layer	0.5502	10	1	0.5502	2	0.2751
Forearms	1003/1500 lb	Lognormal	None	0.1875	10	2	0.0938	4	0.0469
Thighs	1003/1500 lb	Lognormal	None	2.7780	10	2	1.3890	4	0.6945
Lower Legs	1003/1500 lb	Lognormal	None	1.7308	10	2	0.8654	4	0.4327
Hands	1003/1500 lb	Lognormal	None	0.1094	10	1	0.1094	10	0.0109
Dermal							6.1564		4.2209
Inhalation	1003/1500 lb	Lognormal	None	7.9915	10	1	7.9915	1	7.9915

Appendix B - Molinate PHED Data Summary for Study 1003 (MRID 42241501)

Granular Applicator Exposure Data Summary for 1003							
Body Part	Study Code	Distribution Type	Clothing/PPE	Exposure Data (ug/lb ai)	N	Baseline Protection Factor	Baseline Exposure (ug/lb ai)
Head (all)	1003	Lognormal	None	0.3472	9	1	0.3472
Neck Front	1003	Lognormal	None	0.0401	9	1	0.0401
Neck Back	1003	Lognormal	None	0.0294	9	1	0.0294
Upper Arms	1003	Other	Single Layer	0.2910	9	1	0.2910
Chest	1003	Other	Single Layer	0.3550	9	1	0.3550
Back	1003	Other	Single Layer	0.3550	9	1	0.3550
Forearms	1003	Other	Single Layer	0.1210	9	1	0.1210
Thighs	1003	Lognormal	None	0.9307	9	2	0.4654
Lower Legs	1003	Lognormal	None	0.5799	9	2	0.2900
Hands	1003	Lognormal	Gloves	0.0756	9	1	0.0756
Dermal							2.3696
Inhalation	1003	Lognormal	IOM Monitor	1.6597	9	1	1.6597

Granular Flagger Exposure Data Summary for 1003									
Body Part	Study Code	Distribution Type	Clothing/PPE	Exposure Data (ug/lb ai)	N	Baseline Protection Factor	Baseline Exposure (ug/lb ai)	PPE Protection Factor	PPE Exposure (ug/lb ai)
Head (all)	1003	Lognormal	None	0.3456	16	1	0.3456	1	0.3456
Neck Front	1003	Lognormal	None	0.0399	16	1	0.0399	1	0.0399
Neck Back	1003	Lognormal	None	0.0292	16	1	0.0292	1	0.0292
Upper Arms	1003	Lognormal	None	0.7736	16	2	0.3868	4	0.1934
Chest	1003	Lognormal	None	0.9437	16	2	0.4719	4	0.2359
Back	1003	Lognormal	None	0.9437	16	2	0.4719	4	0.2359
Forearms	1003	Lognormal	None	0.3217	16	2	0.1609	4	0.0804
Thighs	1003	Lognormal	None	1.0155	16	2	0.5078	4	0.2539
Lower Legs	1003	Lognormal	None	0.6327	16	2	0.3164	4	0.1582
Feet	1003	Other	None	0.1681	16	1	0.1681	1	0.1681
Hands	1003	no data	Gloves	-	-	-	-	-	-
Dermal							2.8983		1.7405
Inhalation	1003	na data	-	-	-	-	-	-	-

Appendix C
Revised Assessment of Handler Unit Exposures from 1993 Exposure Study for Molinate
EPA MRID# **431656-02**

In May and June of 1993, handlers' molinate exposure were monitored by M. Findlay *et. al*. in Sacramento valley, California during the loading of Ordam10G (granular formulation) for aerial application on rice (EPA MRID# **431656-02** Ordam: Biological Monitoring of Persons Exposed to Molinate During Loading and Application [CA-1993]). During the 1993 study, bulk bags (1,280 lbs) were loaded using two methods: **direct-loading** and **trans-loading**.

A review of this study was included in a HED memo dated May 20,1994 (Bruce Kitchen, Molinate Worker Exposure Conducted in CA Rice Growing Areas in May 92 and June 93). The exposure data provided in this study have been recently revised into a format that can be used for the Registration Eligibility Decision (RED) document that is currently being written for molinate.

The changes made since the 1994 study review include:

* Adding 20% of the mg molinate/day reported for day 3 (or day 2 when values for day 3 were not listed) to account for molinate that has not been excreted (human studies show that following molinate exposure 80% of molinate is excreted in the first 24 hours).

* The data was normalized to "mg molinate exposure/lb ai handled" for comparison.

The study evaluated the effects of personal protective equipment (PPE) and engineering controls as required under the 1993 California permit. The permit required PPE which consisted of a full face respirator, protective gloves, foot coverings, boots, either Tyvek or carbon impregnated coveralls. The carbon impregnated coveralls were worn under normal work clothing. A total of 44 subjects were monitored and their work activities were classified in the following categories:

- ten loaders direct-loading wearing Tyvek suits
- nine loaders direct-loading wearing carbon impregnated suits
- nine loaders both direct and trans-loading wearing Tyvek suits
- six loaders both direct and trans-loading wearing carbon-impregnated suits
- five drivers wearing no protective suits
- five drivers wearing carbon-impregnated suits

Urine samples collected from the 44 handlers were monitored over a four day period. The four days consisted of a baseline or pre-exposure-day followed by three additional days with at least one day in which a minimum of four 1280-lb bags were loaded. A 24-hour urine sample was collected from each handler each monitoring day. The 24-

hour period was from the first void of the day, starting on the baseline or pre-exposure-day to the first void of the following day.

Ideally, no exposure to molinate would have occurred prior to the 4-day monitoring period or on the baseline day, but due to commercial practices of aerial applicators this was not always possible. In several cases, a baseline or pre-exposure without any loading of Ordam could not be obtained. It was also intended that handlers would be loading on day 1, and where this was not possible the first became the baseline or pre-exposure day and the monitoring period was extended one day.

Excluding the collection, moving, and recycling of empty bags, handlers reportedly wore all the PPE required under the permit conditions. Coveralls worn by handlers were either Tyvek or carbon impregnated suits.

Tables 1 and **2** are summaries of exposure data for handlers direct loading. Table 1 contains data for handlers wearing Tyvek suits, whereas Table 2 includes data for handlers wearing carbon- impregnated suits. **Tables 3** and **4** include the same data as Table 1 and 2 but correspond to handlers that direct-loaded as well as trans-loaded Ordam 10G.

The total amount of molinate measured in the urine during the study period (days 1, 2, and 3) was added to 20% of the value for the last day of the study (expressed as "mg/3 days"). The "mg/3 day" value for handler was divided by lb of ai handled during the same 3 days to calculate a unit exposure expressed as "**mg/lb ai handled**". The geometric mean of the unit exposure for each worktask group and suit worn was calculated (i.e., first group: handlers direct-loading Ordam10G for handlers wearing Tyvek suits)

The unit exposures for handlers direct-loading Ordam10G for handlers wearing Tyvek suits and carbon-impregnated suits were 6.76 $x10^{-4}$ mg/lb ai handled and 4.69 $x10^{-4}$ mg/lb ai handled, respectively. For handlers direct- and trans-loading the unit exposures were 8.39 $x10^{-4}$ mg/lb ai handled and 9.48 x 10^{-4} mg/lb ai handled, respectively. Unit exposures for drivers expressed as mg/lb ai handled were not calculated because no data were provided how much they handled.

Table 1. Handlers Wearing **Tyvek** Suits when **Direct-Loading** 1,280-lb bags of ORDAM 10G into Airplane Hoppers

Trial #	Task	PPE Worn	lb of product handled				lb prod handled/ 3 days [1]	mg molinate in urine/day					mg / 3 days [3]	body wt (kg)	ug kg/ 3 days	ug/kg/day	mg/lb ai handled [4]
			Day 0	Day 1	Day 2	Day 3		Day 0	Day 1	Day 2	Day 3	+ 20% [2]					
811	Dir-Lo	Tyvek	1920	16000	21760	12800	50560	0.088	0.411	0.574	0.633	0.127	1.74	103.9	16.8	5.6	0.000345
812	Dir-Lo	Tyvek	1920	16000	21760	12800	50560	0.853	1.090	1.020	1.210	0.242	3.56	99.8	35.7	11.9	0.000705
814	Dir-Lo	Tyvek	0	12800	15360	5120	33280	0.694	1.760	1.060	1.170	0.234	4.22	155.9	27.1	9.0	0.001269
815	Dir-Lo	Tyvek	0	12800	15360	5120	33280	0.239	1.070	1.670	0.484	0.097	3.32	91.2	36.4	12.1	0.000998
828	Dir-Lo	Tyvek	3840	6400	5120	0	11520	0.056	0.123	0.101		0.020	0.24	73.9	3.3	1.7	0.000212
829	Dir-Lo	Tyvek	3840	5120	6400	7040	18560	0.465	0.435	0.225	0.522	0.104	1.29	75.8	17.0	5.7	0.000693
835	Dir-Lo	Tyvek	24960	3200	1280	18880	23360	0.239	0.246	0.112	0.189	0.038	0.58	88.9	6.6	2.2	0.000250
836	Dir-Lo	Tyvek	23680	23680	2560	5760	32000	0.435	0.380	0.127	0.159	0.032	0.70	81.6	8.5	2.8	0.001105
842	Dir-Lo	Tyvek	8960	1920	5760	1920	9600	0.269	0.181	0.505	0.312	0.062	1.06	87.1	12.2	4.1	0.007310
843	Dir-Lo	Tyvek	0	7040	3520	6400	16960	0.136	7.842	3.020	1.280	0.256	12.40	92.1	134.6	44.9	0.000676
							mean: 27968						geomean: 1.65			geomean: 6.2	geomean: 0.000676

Table 2. Handlers Wearing **Carbon Impregnated** Suits when **Direct-Loading** 1,280-lb bags of ORDAM 10G into Airplane Hoppers																	
Trial #	Task	PPE Worn	lb of product handled				lb prod handled/ 3 days [1]	mg molinate in urine/day					mg / 3 days [3]	body wt (kg)	ug kg/ 3 days	ug/kg/day	mg/lb ai handled [4]
			Day 0	Day 1	Day 2	Day 3		Day 0	Day 1	Day 2	Day 3	+ 20% [2]					
805	Dir-Lo	Carbon	0	12800	0	11520	24320	0.015	2.530	0.059	2.570	0.514	5.67	144.7	39.2	13.1	0.002332
806	Dir-Lo	Carbon	0	12800	0	11520	24320	0.021	1.420	0.378	0.413	0.083	2.29	91.2	25.2	8.4	0.000943
808	Dir-Lo	Carbon	0	10240	14080	5120	29440	0.075	0.104	0.126	0.435	0.087	0.75	101.6	7.4	2.5	0.000255
817	Dir-Lo	Carbon	1280	20480	0	11520	32000	0.120	0.267	0.195	0.168	0.034	0.66	103.9	6.4	2.1	0.000207
818	Dir-Lo	Carbon	1280	17920	0	11520	29440	0.501	0.350	0.435	0.172	0.034	0.99	99.8	9.9	3.3	0.000337
820	Dir-Lo	Carbon	3840	7680	0	3840	11520	0.647	0.501	0.079	0.314	0.063	0.96	75.8	12.6	4.2	0.000831
821	Dir-Lo	Carbon	0	5120	0	3840	8960	0.048	0.118	0.053	0.024	0.005	0.20	66.2	3.0	1.0	0.000223
844	Dir-Lo	Carbon	0	5760	0	0	5760	0.020	0.129	0.043	0.063	0.013	0.25	65.3	3.8	1.3	0.000430
845	Dir-Lo	Carbon	0	7680	0	0	7680	0.056	0.188	0.064	0.017	0.003	0.27	103.4	2.6	0.9	0.000355
							mean: 19271						geomean: 0.76			geomean: 2.75	geomean: 0.000469

[1] lb product handled/3 days - the sum of product handled for study period (days 1, 2, and 3)

[2] 20% Day 3 - Since only 80% of molinate is eliminated from the body during first 24 hours the remaining 20% of the last day sampled was calculated

[3] mg molinate in urine/3 days - Sum of molinate measured on days 1, 2, 3 and 20% of last day sampled

[4] mg/lb ai handled = [mg molinate in urine/3 days] ÷ [lb product handled/3 days x 10%]

Table 3. Handlers Wearing **Tyvek** Suits when **Direct and Trans-Loading** 1,280-lb bags of ORDAM 10G into Airplane Hoppers

Trial #	Task	PPE Worn	lb of product handled				lb prod handled/ 3 days [1]	mg molinate in urine/day					mg / 3 days [3]	body wt (kg)	ug kg/ 3 days	ug/kg/day	mg/lb ai handled [4]
			Day 0	Day 1	Day 2	Day 3		Day 0	Day 1	Day 2	Day 3	+ 20% [2]					
802	Both	Tyvek	0	17280	17920	14580	49780	0.007	0.110	0.276	0.756	0.151	1.29	101.6	12.7	4.2	0.000260
803	Both	Tyvek	0	12800	0	0	12,00	0.015	0.536	0.104	0.056	0.011	0.71	94.3	7.5	2.5	0.000553
822	Both	Tyvek	0	14080	1920	2560	18560	0.017	1.310	0.567	0.239	0.048	2.16	71.7	30.2	10.1	0.001166
823	Both	Tyvek	0	19200	7680	5120	32000	0.044	3.120	0.888	1.160	0.232	5.40	103.4	52.2	17.4	0.001688
824	Both	Tyvek	0	10240	5120	6400	21760	0.038	0.406	0.350	0.181	0.036	0.97	92.1	10.6	3.5	0.000447
838	Both	Tyvek	34880	6400	0	33600	40000	1.570	0.713	0.274	1.050	0.210	2.25	94.8	23.7	7.9	0.000562
839	Both	Tyvek	34880	8960	0	14720	23680	5.340	2.810	0.213	1.410	0.282	4.72	91.6	51.5	17.2	0.001991
840	Both	Tyvek	0	5120	0	0	5120	0.005	0.879	0.092	0.152	0.030	1.15	65.3	17.7	5.9	0.002253
841	Both	Tyvek	0	7680	3840	6400	17920	0.118	0.487	0.179	0.411	0.082	1.16	103.4	11.2	3.7	0.000647
							mean: 24624						geomean: 1.74			geomean: 6.5	geomean: 0.000839

Table 4. Handlers Wearing **Carbon** Suits when **Direct and Trans-Loading** 1,280-lb bags of ORDAM 10G into Airplane Hoppers

Trial #	Task	PPE Worn	lb of product handled				lb prod handled/ 3 days [1]	mg molinate in urine/day					mg / 3 days [3]	body wt (kg)	ug kg/ 3 days	ug/kg/day	mg/lb ai handled [4]
			Day 0	Day 1	Day 2	Day 3		Day 0	Day 1	Day 2	Day 3	+ 20% [2]					
809	Both	Carbon	0	10240	12800	5120	28160	0.150	0.487	2.360	2.190	0.44	5.48	94.8	57.8	19.3	0.001944
826	Both	Carbon	6400	4480	8960	38400	51840	1.850	1.010	0.520	0.680	0.14	2.35	94.3	24.9	8.3	0.000453
827	Both	Carbon	2560	4480	3840	20480	28800	1.030	1.040	0.737	1.042	0.21	3.03	91.6	33.0	11.0	0.001051
831	Both	Carbon	0	6400	0	19200	25600	0.155	0.907	0.359	3.170	0.63	5.07	71.7	70.7	23.6	0.001980
832	Both	Carbon	0	21760	0	0	21760	0.328	1.430	0.803		0.16	2.39	103.4	23.1	11.6	0.001100
833	Both	Carbon	0	23040	0	16640	39680	0.129	0.454	0.260	0.595	0.12	1.43	92.1	15.5	5.2	0.000360
							mean: 32640						geomean: 2.96			geomean: 11.6	geomean: 0.000948

[1] lb product handled/3 days - the sum of product handled for study period (days 1, 2, and 3)

[2] 20% Day 3 - Since only 80% of molinate is eliminated from the body during first 24 hours the remaining 20% of the last day sampled was calculated

[3] mg molinate in urine/3 days - Sum of molinate measured on days 1, 2, 3 and 20% of last day sampled

[4] mg/lb ai handled = [mg molinate in urine/3 days] ÷ [lb product handled/3 days x 10%]

Table 5. Drivers no suits												
Trial #	**Task**	**PPE Worn**	**mg molinate in urine/day**					**mg molinate in urine/ 3 days**	**body wt (kg)**	**ug molinate kg bdy wt/ 3 days**	**ug molinate/ kg bdy wt/ day**
			Day 0	Day 1	Day 2	Day 3	**20%** Day 3				
801	Driv	none	0.002	0.040	0.115	0.129	0.026	0.31	68.9	4.5	1.50
810	Driv	none	0.022	0.045	0.016	0.040	0.008	0.11	66.7	1.6	0.54
813	Driv	none	0.035	0.117	0.084	0.085	0.017	0.30	112.0	2.7	0.90
834	Driv	none	0.026	0.021	0.018	0.018	0.004	0.06	82.6	0.7	0.24
837	Driv	none	0.276	0.267	0.055	0.162	0.011	0.50	83.5	5.9	1.98
								0.20			0.81

Table 6. Drivers Wearing CARBON Suits											
Trial #	Task	PPE Worn	mg molinate in urine/day					mg molinate in urine/ 3 days	body wt (kg)	ug molinate kg bdy wt/ 3 days	ug molinate/ kg bdy wt/ day
			Day 0	Day 1	Day 2	Day 3	**20%** Day 3				
804	Driv	carbon	0.013	0.042	0.057	0.111	0.022	0.23	112.0	2.1	0.69
807	Driv	carbon	0.024	0.015	0.105	0.020	0.004	0.14	68.9	2.1	0.70
816	Driv	carbon	0.041	0.018	0.023	0.029	0.006	0.08	66.7	1.1	0.38
819	Driv	carbon	0.011	0.015	0.024	0.008	0.002	0.05	73.9	0.7	0.22
825	Driv	carbon	0.155	0.108	0.146	0.181	0.029	0.46	83.5	5.6	1.85
								0.14			0.59

Appendix D - EPA MRID# **442122-01** Molinate's: Biological Monitoring of Workers During Loading of Arrosolo 3-3E into Airplane Hoppers

Activated Carbon under Kleengard (Level 1)								
trial #	Worker ID	total mg molinate(Day 2-4)	gallons handled	lb ai handled	mg/lb ai handled	bdy wt	mg/kg/day	
4301	1	0.312	242	725	0.000431	81	0.0039	
4302	2	0.244	242	725	0.000337	84	0.0029	
4303	3	0.125	206	618	0.000202	70	0.0018	
4304	4	0.338	206	618	0.000547	67	0.0050	
4312	5	0.742	308	924	0.000803	93	0.0080	
4313	6	0.620	308	924	0.000671	89	0.0070	
4306	7	0.555	230	690	0.000804	86	0.0065	
4307	8	0.278	230	690	0.000403	85	0.0033	
4308	9	0.415	126	378	0.001098	65	0.0064	
4309	10	2.420	126	378	0.006402	71	0.0341	
4314	11	1.160	390	1170	0.000991	73	0.0159	
4305	12	0.252	493	1479	0.000170	89	0.0028	
4316	13	0.031	168	504	0.000062	82	0.0004	
4317	14	0.071	168	504	0.000141	80	0.0009	
4334	15	0.618	197	591	0.001046	111	0.0056	
4310	16	14.700	500	1500	0.009800	68	0.2162	
4311	49	2.030	500	1500	0.001353	61	0.0333	
4332	50	3.070	338	1014	0.003028	93	0.0330	
4333	51	4.100	338	1014	0.004043	120	0.0342	
			280 mean	**839 mean**	**0.000756 GM**	**83 mean**	**0.0222**	**mean**
							0.0072	**GM**

Kleengard over normal clothing (Level 2)								
trial #	Worker ID	total mg molinate(Day 2-4)	gallons handled	lb ai handled	mg/lb ai handled	bdy wt	mg/kg/day	
4318	17	0.904	131	393	0.002300	81	0.0112	
4319	18	0.690	131	393	0.001756	84	0.0082	
4320	19	0.162	147	441	0.000367	70	0.0023	
4321	20	0.110	147	441	0.000249	67	0.0016	
4322	21	0.402	500	1500	0.000268	73	0.0055	
4323	22	1.870	290	870	0.002149	86	0.0217	
4324	23	0.727	290	870	0.000836	85	0.0086	
4325	24	0.335	255	765	0.000438	65	0.0052	
4326	25	1.620	255	765	0.002118	71	0.0228	
4329	28	0.321	138	414	0.000775	89	0.0036	
4330	29	0.328	500	1500	0.000219	89	0.0037	
4331	30	3.160	500	1500	0.002107	80	0.0395	
4337	31	3.440	270	810	0.004247	93	0.0370	
4338	32	8.040	270	810	0.009926	120	0.0670	
4339	52	0.262	195	585	0.000448	111	0.0024	
4335	53	6.110	420	1260	0.004849	68	0.0899	
4336	54	3.210	420	1260	0.002548	61	0.0526	
			286 mean	**857 mean**	**0.001167 GM**	**82 mean**	**0.0225**	**mean**
							0.0111	**GM**

Normal Clothing (Level 3)

trial #	Worker ID	total mg molinate(Day 2-4)	gallons handled	lb ai handled	mg/lb ai handled	bdy wt	mg/kg/day	
4341	33	1.715	380	1140	0.001504	81	0.0212	
4342	34	1.42	380	1140	0.001246	84	0.0169	
4343	35	2.449	136	408	0.006002	70	0.0350	
4344	36	3.224	136	408	0.007902	67	0.0481	
4345	37	1.579	469	1407	0.001122	86	0.0184	
4346	38	1.03	469	1407	0.000732	85	0.0121	
4347	39	1.144	208	624	0.001833	65	0.0176	
4348	40	2.389	208	624	0.003829	71	0.0336	
4349	41	0.827	211	633	0.001306	89	0.0093	
4358	42	17.31	344	1032	0.016773	68	0.2546	
4359	43	8.87	342	1026	0.008645	61	0.1454	
4352	44	1.033	196	588	0.001757	82	0.0126	
4353	45	2.266	196	588	0.003854	80	0.0283	
4354	46	1.934	90	270	0.007163	73	0.0265	
4355	47	4.66	136	408	0.011422	93	0.0501	
4356	48	5.054	136	408	0.012387	120	0.0421	
4357	55	1.037	215	645	0.001608	111	0.0093	
			250	**750**	**0.003398**	**82**	**0.0460**	**mean**
			mean	**mean**	**GM**	**mean**	**0.0284**	**GM**